MARCH 13, 1959

electronics

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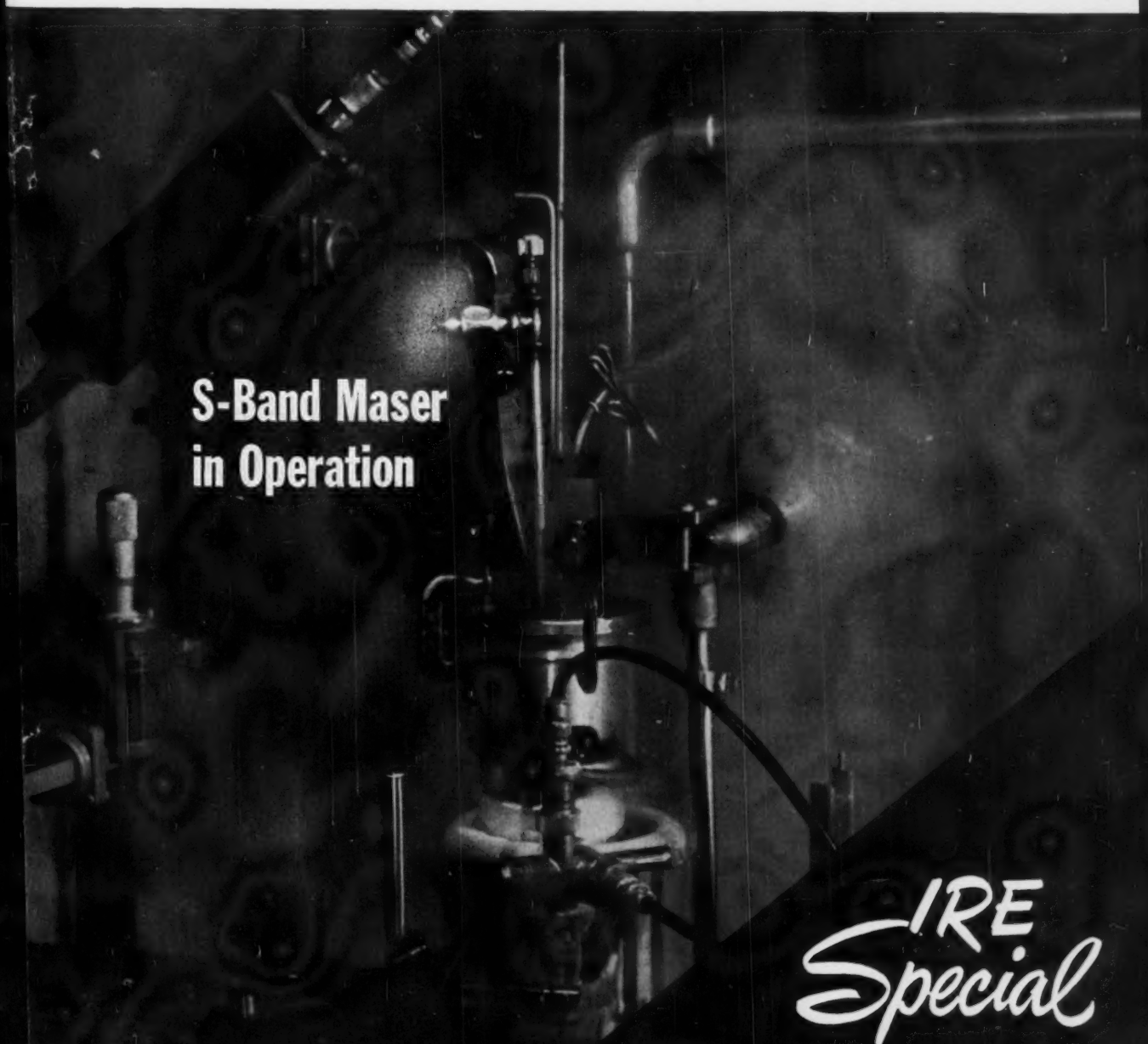

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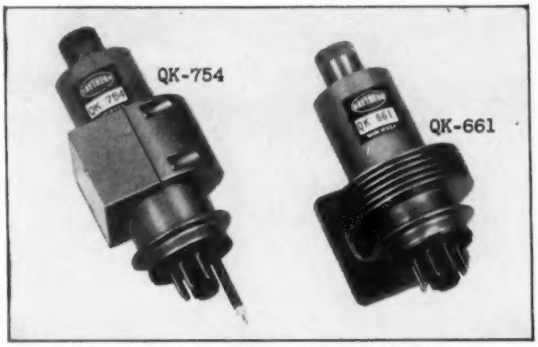
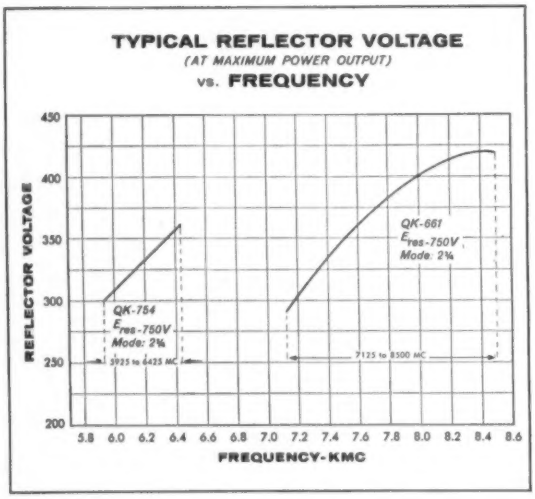
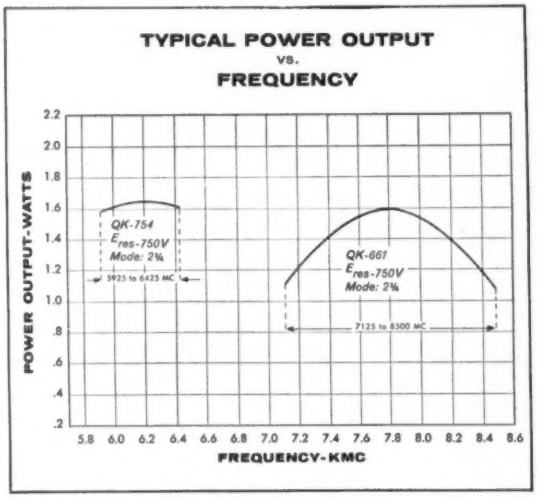
To insure efficient operation the tubes are available with integral cooling fins or with a heat-sink attachment suitable for connection to the chassis.



Typical operating characteristics

	QK-754	QK-661
Frequency Range	5925 to 6425 Mc	7125 to 8500 Mc
Power Output	1.5 watts	1.6 watts
Electronic Tuning (to half-power pts)	50 Mc	25 Mc
Modulation Sensitivity (10 V pk-to-pk mod volt)	1 Mc/V	600 Kc/V
Temp. Coefficient	± 0.1 Mc/°C	± 0.1 Mc/°C





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MARCH 13, 1959

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Vol. 32 No. 11

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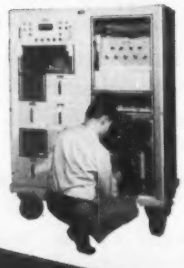

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Mar. 13, 1959 Vol. 32, No. 11

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INDUSTRY CHATTER. According to IRE show exhibitors the electronics industry was tested last year by the fires of military cutbacks and reduced capital-goods buying. But the industry emerged bigger and better than ever. Some major long-term gains: We now have salesmen who know how to sell and production executives who know how to get the most out of a dollar spent. Last summer's military-cutback binge also spurred development of new commercial markets.

Missile-and-aircraft electronics producers are sitting comfortably on a $4-billion backlog. Overall industry censensus is that sales in 1959 will top 1958 by a whopping 8 percent. But, best of all, the net will be up too. On p 51, Associate Editor Emma tells you in detail why "IRE Exhibitors See Good Year."

ENGINEERS' FORTUNES. Despite lingering effects of the recession in some industries, and dire predictions and judgments on displacement of workers and/or industry's reluctance to rehire, it's still a seller's market for electronics engineers. Demand, as evidenced by January help-wanted advertising volume, was the highest ever. Most of the demand originated with firms heavily in the missile-rocket-space portion of our field. Competition is keenest for younger engineers with a few years' specialized experience in our industry. Demand for new college graduates has about stabilized at last year's high level. All told, this is an interesting story. Associate Editor Janis looks on as "Recruiters Roll Up Sleeves." And, on p 56, he tells you what he sees.

Coming In Our March 20 Issue . . .

SPACE POWER. As man heads into space by way of missiles and satellites, the need for lightweight, long-lasting sources of energy to power electronic and other auxiliary equipment becomes critical.

Next week, D. Linden and A. F. Daniel, of the U. S. Army Research & Development Labs, describe the latest developments in chemical, nuclear and solar energy sources for space-age electronics. You'll learn about nuclear batteries, photogalvanic devices, thermionic converters, chemical fuel cells and other significant systems for providing energy in space.

RANDOM EVENT ENCODER. Knowledge of elapsed time between consecutive but random events can be used in control and analysis of pulse jitter in ptm and pcm communications systems, as well as in forming statistical distributions in nuclear radiation studies.

ITT Laboratories' R. J. Kelso and J. Groce have developed a technique using a transistorized encoder in conjunction with a cathode-ray display circuit which permits photographic records to be made of random time intervals. Records are in one-microsecond intervals.

DISTRIBUTED AMPLIFIERS. Principles of distributed amplification are fairly well-known, but considerable progress has been made in recent years in establishing design criteria for voltage amplifiers employing these principles.

S. K. Meads of the U. S. Naval Research Labs in Washington outlines the design procedures to follow in determining all the required parameters of a basic distributed amplifier with low-pass, constant-K filter sections.

HIGH-SPEED SWITCH. A unique application of a beam-switching tube is employed in an instrument that measures and records data on the application of pressure to an automobile seat.

A. Stiebel of the Rockwell-Standard Corp., in Birmingham, Mich., describes how the tube switches the outputs of ten bridges to an oscilloscope and yields data which is of value in automotive seating design.

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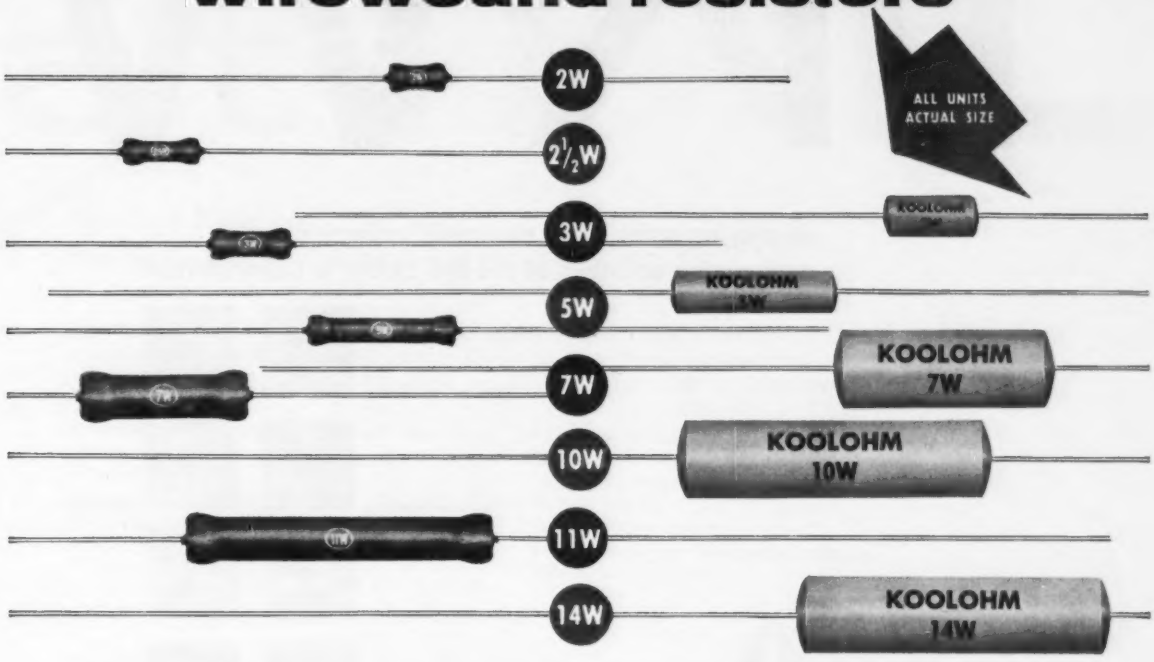

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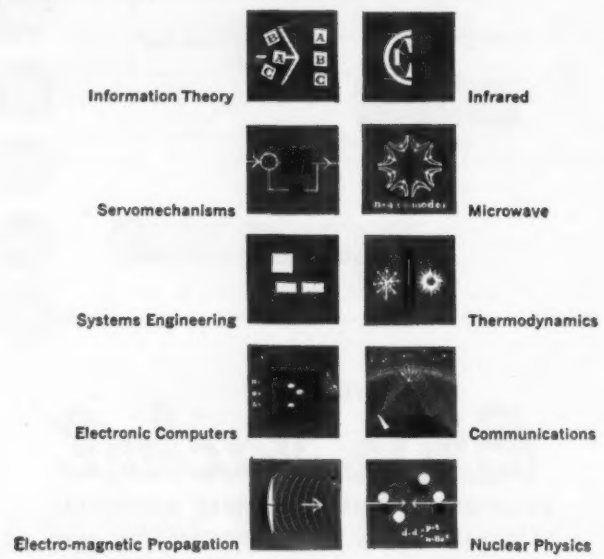

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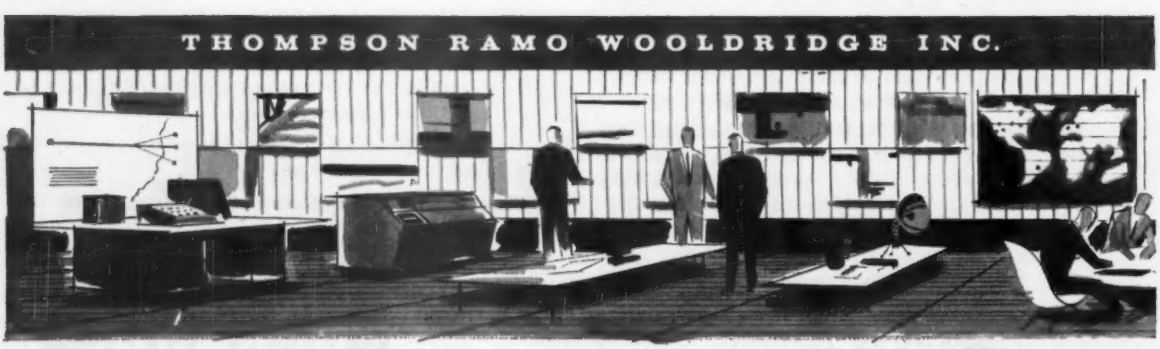

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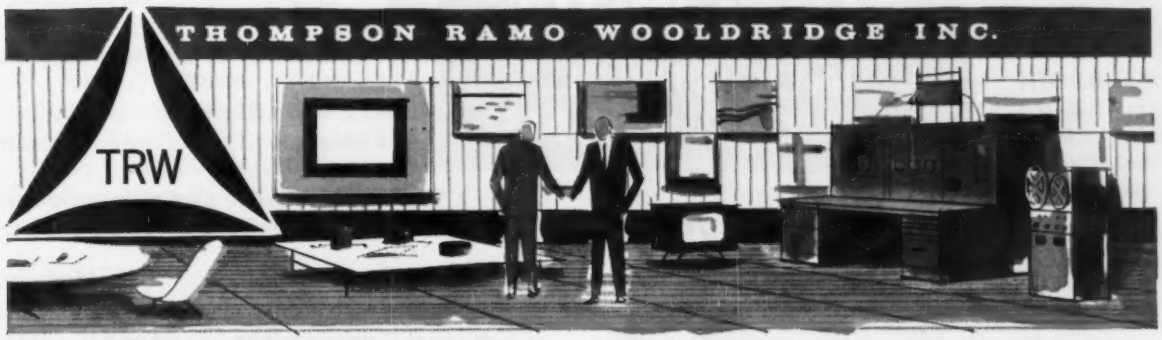

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a continuing series on technical topics of specific interest to engineers

What is the true value of high purity aluminum foil in electrolytic capacitors?

Since the word "purity" is relative, the term "high purity" in describing the foil used in electrolytic capacitors has been often misused. Twenty years ago, 99.80% aluminum was the highest purity commercially available. A few years later, 99.85% aluminum anodes became available and for a period of time were considered "high purity" foil.

Today, 99.99% aluminum is readily available for applications where the cost differential between 99.99% and standard purity anodes is justifiable. In some technical circles, purities of 99.85% to 99.87% aluminum are still referred to as "high purity". At Sangamo Electric Company high purity means 99.99% aluminum or better anode foil.

From the engineer's viewpoint, the advantage of 99.99% aluminum over 99.87% aluminum in electrolytic capacitors is both tangible and intangible. Most of the benefits are derived from the fact that there are fewer crystals of metal impurities on the surface of the higher purity foil. Crystal impurities such as iron do not form an insulating dielectric oxide and produce points of high electrical leakage. In a circuit, where capacitors of lower anode aluminum purity are used, voltages are set up between the dissimilar metals and deformation, or point corrosions, slowly takes place. This action decreases the shelf life of the capacitor.

Other benefits provided from the use of 99.99% aluminum foil include longer life, better high temperature operation and lower dissipation factor. When variable factors are equal, the summary advantages of 99.99% anodes versus 99.87% anodes can be shown as follows:

	99.87% Anodes	99.99% Anodes
DC leakage	Per Mil-C-62A or EIA-RS-154	EIA-TR-140 or about ½ leakage for 99.87% anodes
Shelf life	2 years	2½—3 years
Estimated life expectancy	4—7 years	7—12 years

Where extremely low leakage is important, where temperature of operation is between 65°C and 85°C, or where exceptional long life is required and something better than standard electrolytic capacitors is desired, 99.99% aluminum anodes are well worth the additional cost.

Capacitor manufacturers, like Sangamo, pay a premium of approximately 60% more for 99.99% aluminum foil. To obtain this near-perfect purity, the aluminum ingots used to produce 99.99% anodes must be reprocessed from a good supply of bauxite and a well run electro-chemical process.

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ELECTROLYTIC CAPACITORS
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Engineering Catalog Number 2227 gives full information and is available upon request for your files.

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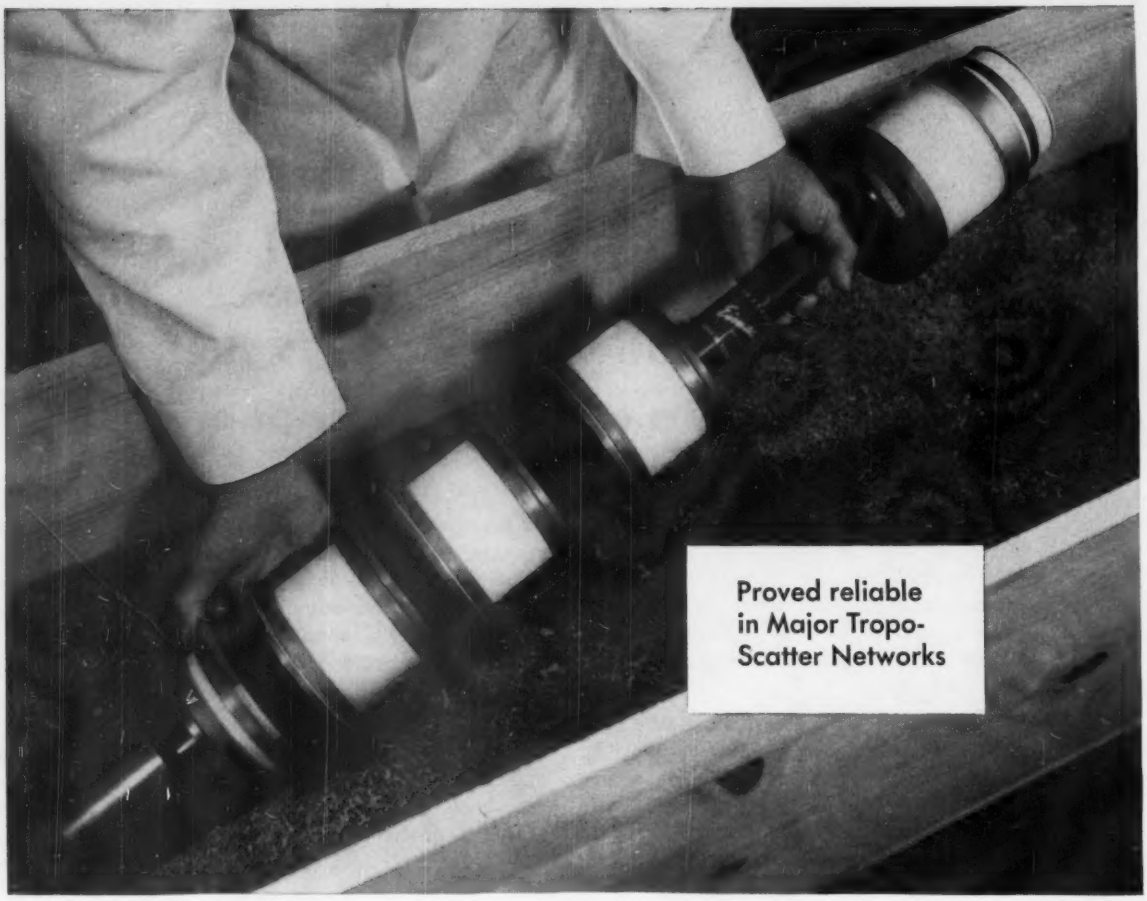

Field experience indicates

15,000 hours from now, this Eimac 2KW KLYSTRON will still be in service

After three years of widespread service in such tropo-scatter systems as Dew Line, White Alice and Texas Towers, typical life of Eimac 3K3000LQ klystrons is nearing 15,000 hours and still increasing. Experience with Eimac klystrons in these and other tropo-scatter systems indicates that the 3K3000LQ will easily exceed 15,000 hours typical life. This exceptional record of long life and high performance is the result of Eimac's conservative design and advanced manufacturing techniques.

The Eimac 3K3000LQ is a 2 kilowatt klystron covering the frequency range of 610 to 985 megacycles. It will tune over the entire frequency range with one set of external cavities and is capable of meeting the bandwidth requirements of modern tropo-scatter systems.

Eimac's external-cavity design permits this wide tuning range and bandwidth, and also eliminates problems inherent in flexible vacuum seals. Systems' operating costs are significantly lowered since tuning circuitry need not be repurchased when tubes are replaced.

ON THE AIR AT THE I.R.E. SHOW

During the I.R.E. Show, March 23-26 in New York, an Eimac Klystron will be in operation at 800 megacycles with one kilowatt output power. Visit the Eimac Booths, 2410-11-12, and see the simplicity and non-critical tuning of Eimac Klystrons by tuning this operating klystron yourself.

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ELECTRONICS NEWSLETTER

VOR-DMET win over U. K.-sponsored Decca short-range air-navigation system as the international standard will probably mean eventual orders for hundreds of millions of dollars for navigational equipment from U. S. manufacturers. Recent Montreal meeting of the International Civil Aviation Organization approved protection of DMET until at least Jan. 1, 1975, extended VOR, the international standard since 1949, to the same date. (For pre-vote rundown of the worldwide debate see ELECTRONICS, p 30, Feb. 27). DMET still must go to ICAO's air navigation commission for approval. Half of the member states were not present for the recent vote and must be heard from. Finally, ICAO's Council must give its blessing before the standard is official. All this may take another six months.

A-M STEREOPHONIC broadcasting system demonstrated last week by Westinghouse achieves its stereo signal by simultaneous amplitude and frequency modulation of the carrier. Firm says the new system is compatible with present FCC a-m broadcast standards; a-m is essentially that of a normal broadcast band signal. Stereo information in the 300 to 3,000 cps band is supplied by varying carrier frequency. Westinghouse claims such transmission of a-m and f-m signals permits a standard a-m receiver to pick up and reproduce distortion-free, balanced monophonic sound. Two standard a-m sets, one tuned to the low side of the a-m channel and the other to the high side, or a specially designed single receiver, are needed to reproduce stereo, says the firm.

Automatic ultrasonic vapor degreasers for aircraft engine components will be supplied to USAF by The Narda Ultrasonic Corp., Westbury, N. Y. Cleaning output of 300 to 400 strainers is estimated for an eight-hour day, compared to 6 to 8 by manual means.

ELECTRONIC R&D CONTRACTS relating to the Aircraft Nuclear Propulsion (ANP) project will probably be scanty again in the coming fiscal year. That's the upshot for electronics firms of the Administration's recent turndown of Air Force and AEC recommendations for a substantial increase in spending for the project. Earlier policy decision had essentially limited R&D to propulsion systems, but there had been some hope of accelerating the overall program in the next fiscal year. Program is slated to continue at its present $100-million-a-year spending level. The 1964 target date for the first flight of a nuclear-powered plane has been scrapped, according to *Nucleonics*, a McGraw-Hill magazine. The Democratic majority on the Joint Congressional Committee on Atomic Energy is certain to fight the hold-down tooth and nail, but the outcome is in doubt.

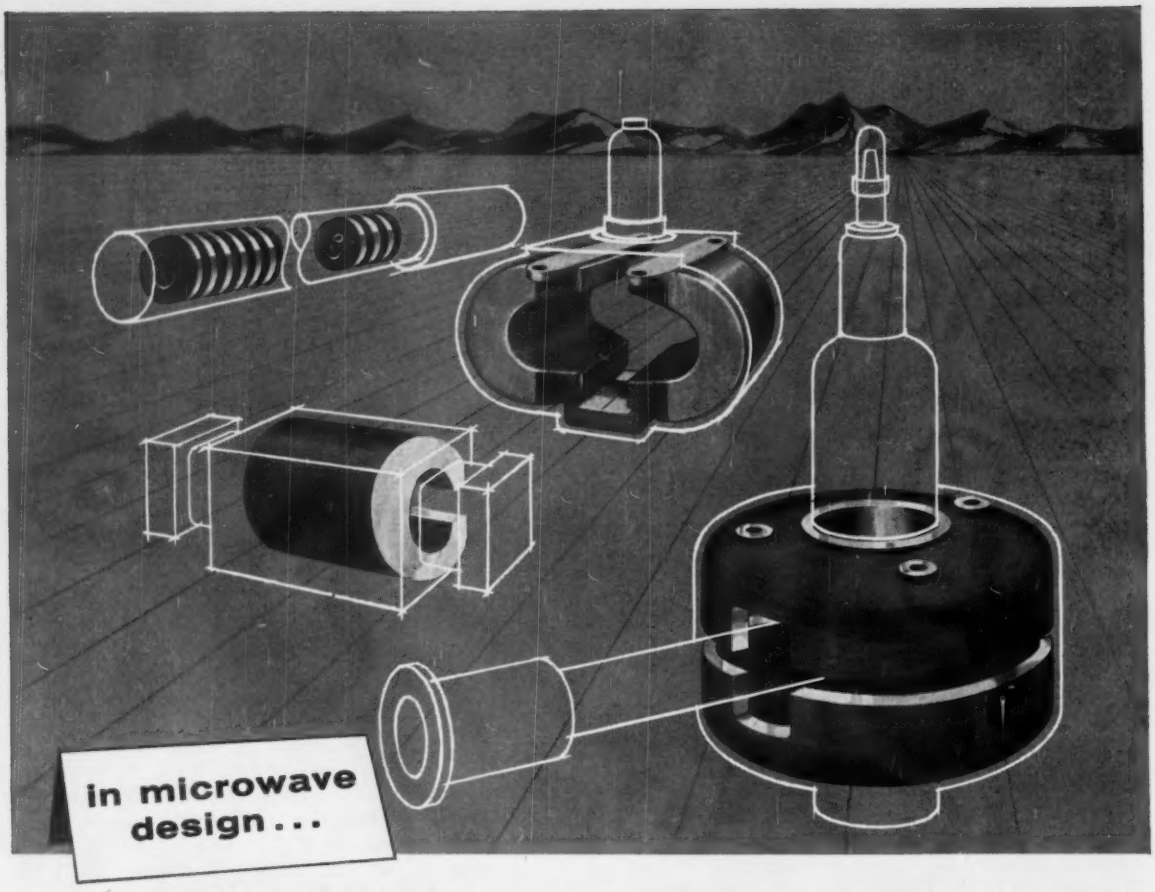
MULTIOBJECT TRACKING GEAR will be provided FAA's National Aviation Facility Experimental Center in Atlantic City, N. J., under a $721,000 contract awarded to Cubic Corp., San Diego, Calif. Firm says the equipment will track the paths of five aircraft of all types simultaneously within a radius of 200 mi and with an accuracy to within five feet; it claims that additional gear could be added to give the system a capability of monitoring more than 400 aircraft at once. Cubic says the gear is also capable of making use of tropospheric scatter in the future.

Helicopter radar system weighing 75 lb and powered by available aircraft power has been developed for low-flying battlefield operations by the Pacific division of Bendix Aviation Corp. Antenna is 40 in. long, 3 in. wide, scans at 60 rpm.

FRANCE'S representative at last year's Geneva conference on detecting nuclear explosions has developed a seismograph capable of signaling a vibration of only 20 angstroms in the earth's crust. Yves Rocart, Director of the Physics Laboratory of Ecole Normale Superieure, believes the instrument opens new horizons in detection capability. Electronic amplifier circuit is said to allow detection of vibration hitherto too feeble to register. The instrument uses the principle of a suspended metallic mass.

PROCESS CONTROL transistor computer measuring 4 × 4 × 2 ft is being developed by Ferranti, Ltd., with first production models expected to be available in 1960. Firm says prototype has controlled a machine which simulates a plant process for more than 2,000 hours without component failure. The computer is being developed as the central unit in control systems for processes in the power, chemical, oil, gas and steel industries.

COAST GUARD'S International Ice Patrol is conducting a worldwide survey to determine how ship masters can best use radar to avoid collisions with icebergs. Recent sinking of the radar-equipped *Hans Hedtoft* after an iceberg collision underscored the fact that more than a decade has passed since the Coast Guard's last radar study. Raytheon, which conducted its own study of marine radar three years ago, is cooperating with Coast Guard oceanographers.



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WASHINGTON OUTLOOK

A PENTAGON PLAN is in the works to centralize military procurement of electron tubes. The proposal is now under study by an interservice committee of logistics experts. Final decision on the issue is due by April 15.

Under the scheme, one of the three services would be assigned to do all buying of both common-type and special electron tubes for military consumption. In all probability, the service selected would then designate one of its field procurement offices to do most, if not all, of the actual purchasing.

The tube proposal is part of a Defense Dept. campaign to set up single managers or single buyers for common-use commodities bought by the military in large quantity. For instance, the Navy and Army already act as single managers. The Navy manages medical supplies, the Army textiles.

A single purchase assignment on electron tubes would "facilitate doing business with the Defense Department," one Pentagon official says. "There is the benefit of scheduled procurement with an orderly impact on total production capacity." Some supply officials also claim a saving in costs. But Pentagon budget experts feel the savings are negligible.

The Electronic Industries Association opposes the consolidated tube buying proposal. EIA has told the Pentagon the scheme would eliminate competition among suppliers, hurt smaller firms unable to produce in larger quantities, and result in the shutdown of some production facilities.

Among factors being studied in detail, before a decision on consolidation of electron tube procurement is officially made, are these: (1) The degree of universality in tube requirements among the services; (2) the amount of concurrent buying and selling—if any; and (3) the industrial concentration of suppliers.

If the decision is made to consolidate procurement of electron tubes, the Air Force stands out as the service most likely to get the purchasing assignment. It now buys $42 million worth of the Pentagon's $63-million annual bill for electron tubes. The Navy buys $18 million worth, the Army $3 million.

- **Although the Army** has gotten some Congressional support in its fight to start production of Western Electric's Nike-Zeus antimissile missile system, the Pentagon will stand firm on its decision not to authorize new plant construction and procurement of production tooling.

  But under pressure from the Democratic-controlled House Space Committee, Defense Secy. McElroy has made a token move to pacify critics of the Nike-Zeus policy: He has ordered an "intensive study on pre-production planning measures to determine ways to shorten the time between the freezing of component design and the start of production."

  Pentagon insiders, however, consider the study an academic measure which will still fall far short of the Army's basic demand: The addition of some $700 million to the fiscal 1960 budget to begin production.

  But the Administration's top echelon still holds that a best defense is a good offense, that instead of spending $7-billion-plus on production of the Nike-Zeus system, the bulk of defense spending should continue to be earmarked for maintaining and expanding a nuclear striking force—bombers, ballistic missiles, and such.

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TECHNICAL DATA

Typical Electrical Characteristics at 25°C

2N1147 Series has solder lugs 2N1146 Series has standard pins	2N1147 2N1146	2N1147A 2N1146A	2N1147B 2N1146B	2N1147C 2N1146C
Collector to Emitter Voltage Shorted Base (IC = 1 amp)	30V (Min)	40V (Min)	60V (Min)	75V (Min)
Saturation Voltage (IC = 15 amps)	1.0V (Max)	1.0V (Max)	1.0V (Max)	1.0V (Max)
DC Current Gain (IC = 5 amps)	60-150	60-150	60-150	60-150
DC Current Gain (IC = 15 amps)	35	35	35	35
Absolute Maximum Ratings				
Collector Current	15 amps	15 amps	15 amps	15 amps
Collector to Base Voltage	40V	60V	80V	100V
Collector to Emitter Voltage	40V	60V	80V	100V
Power Dissipation at 70°C Case Temperature	25W	25W	25W	25W
Junction Temperature	95°C	95°C	95°C	95°C

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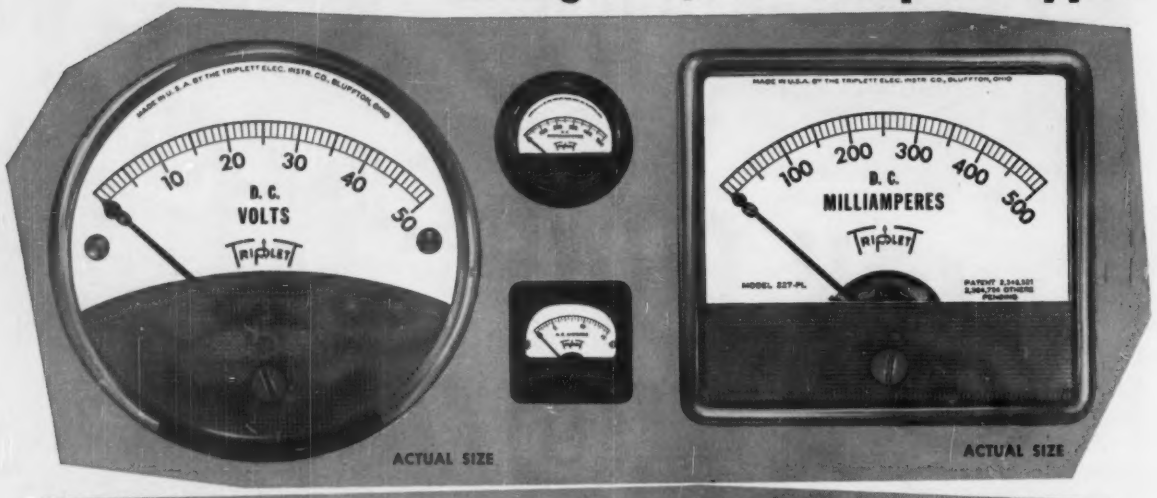

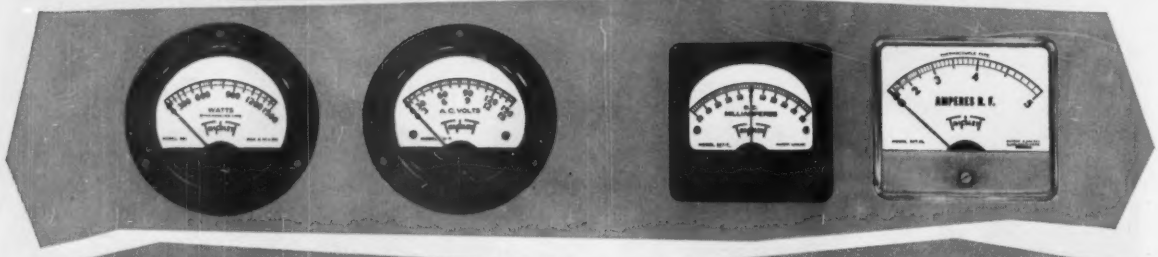

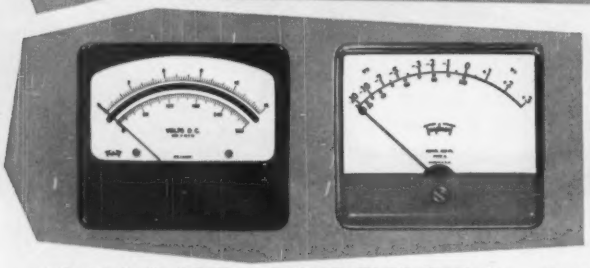

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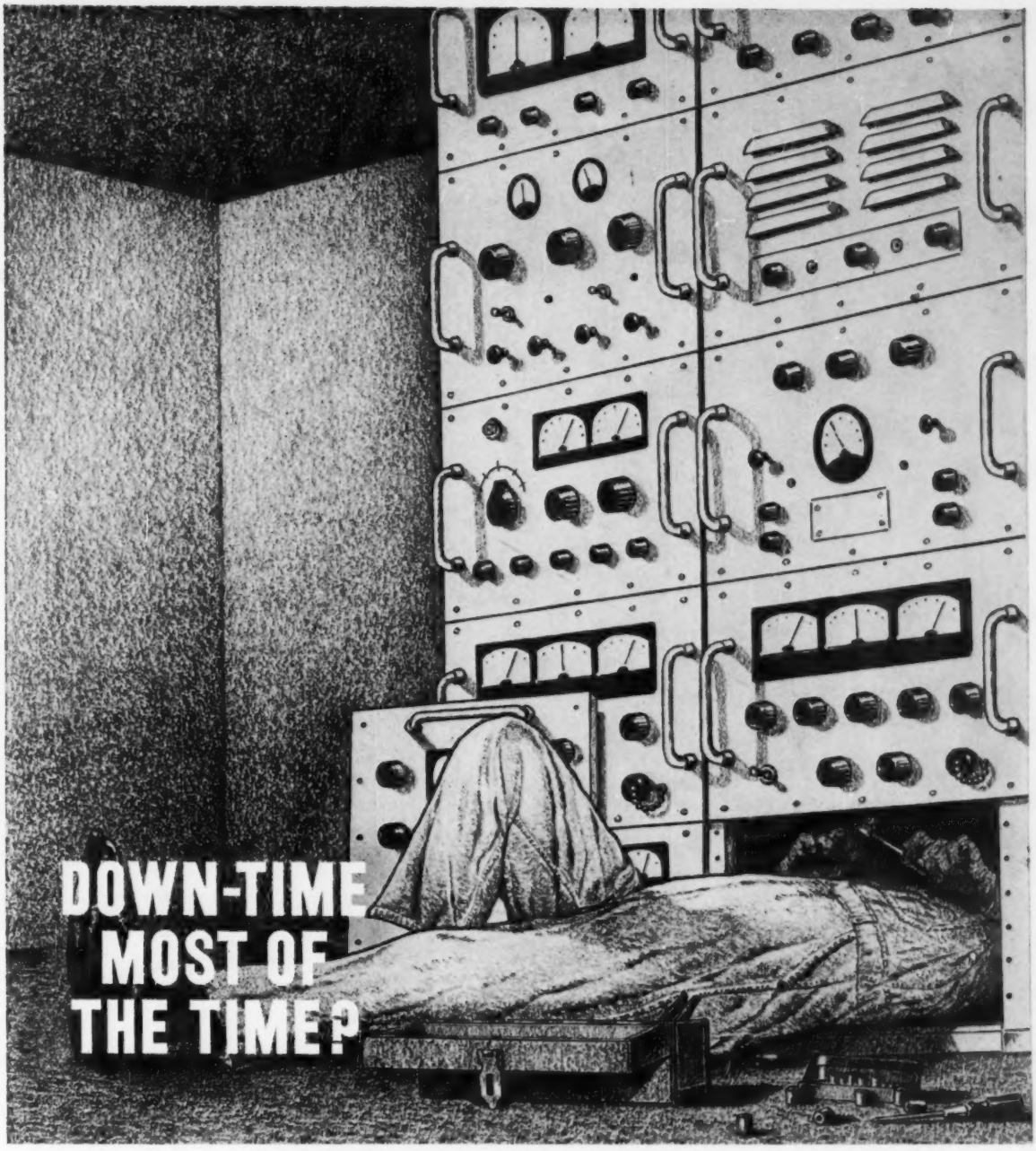

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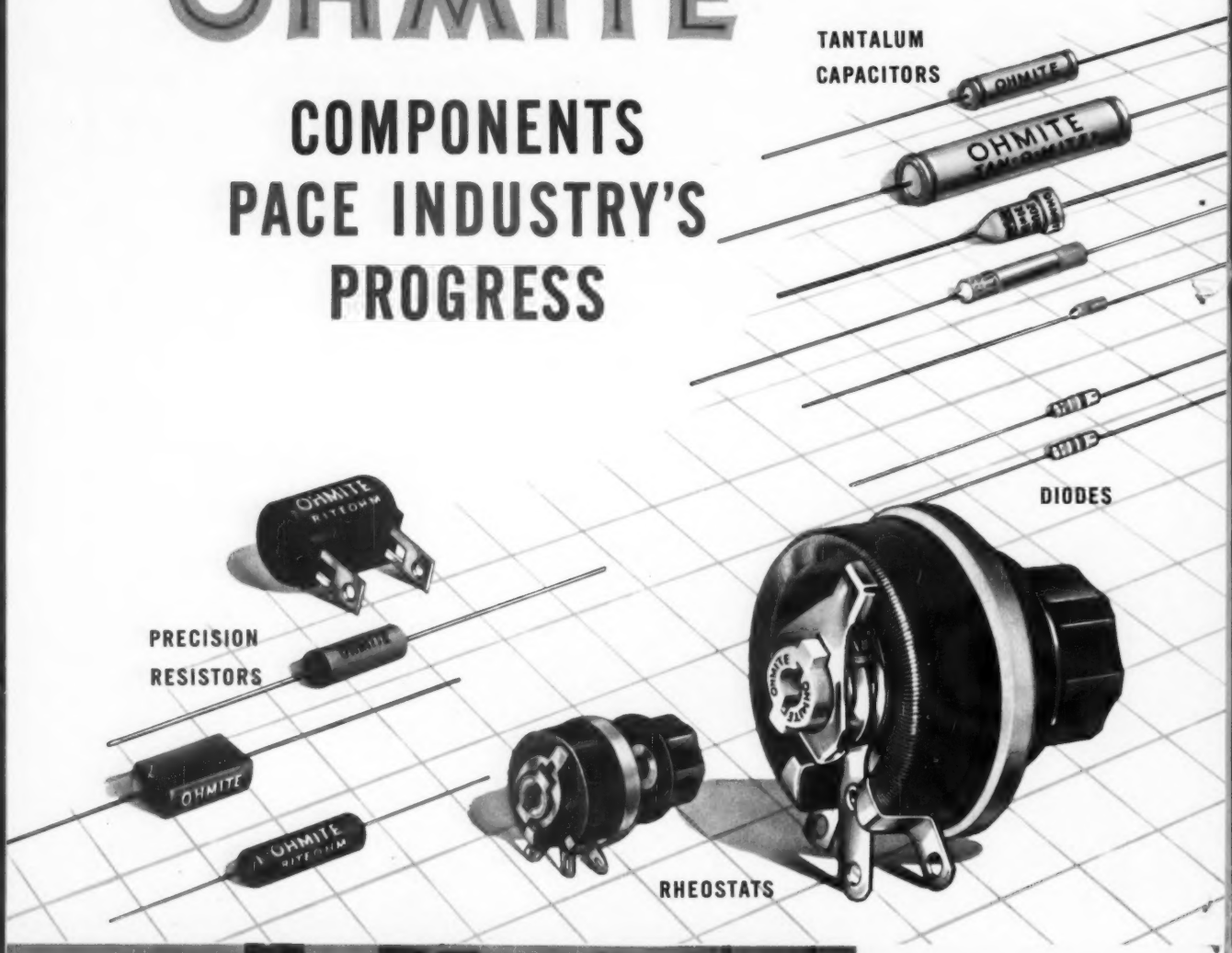

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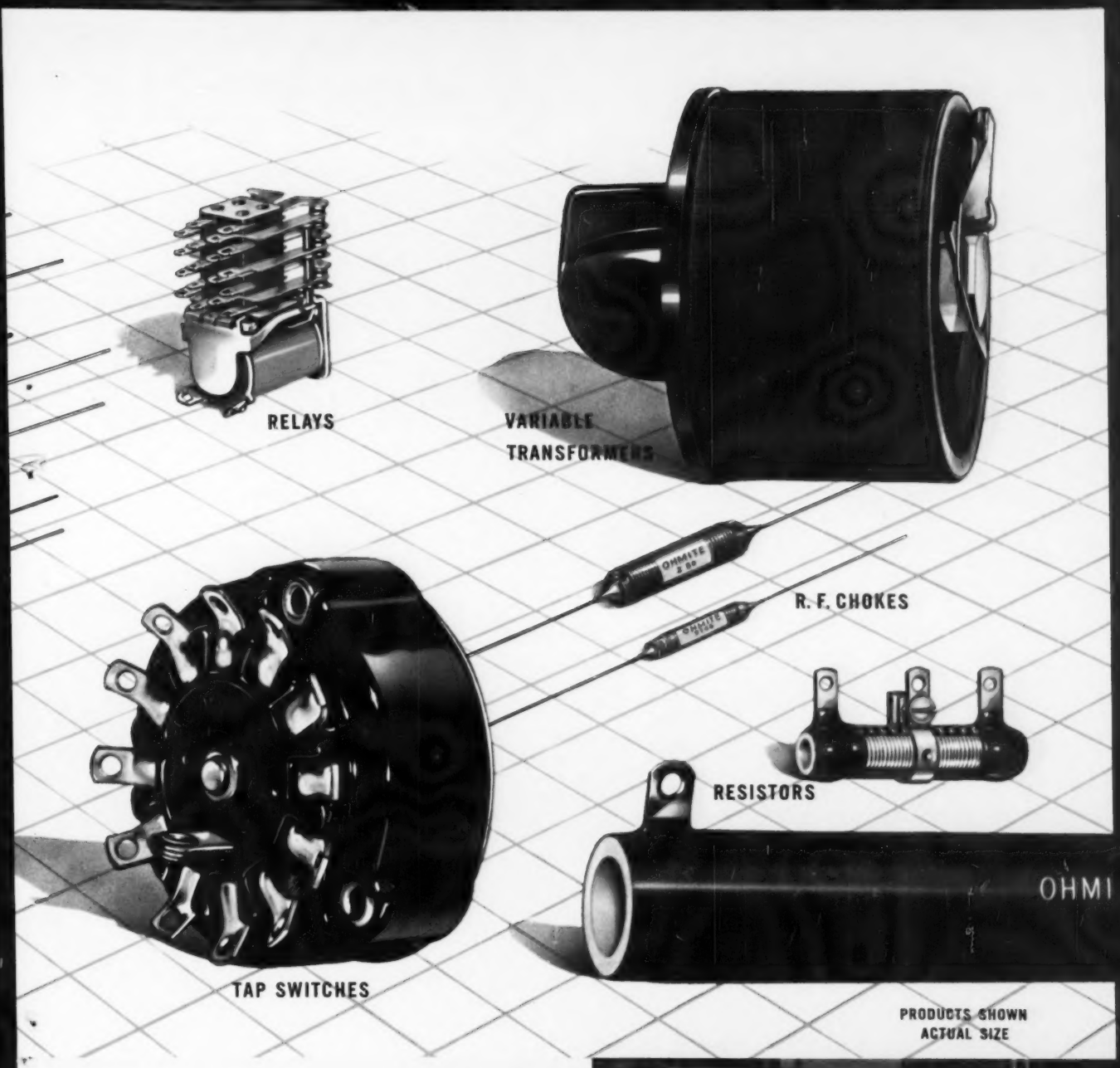

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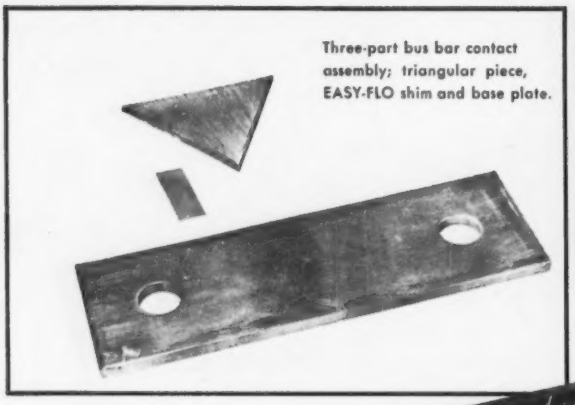
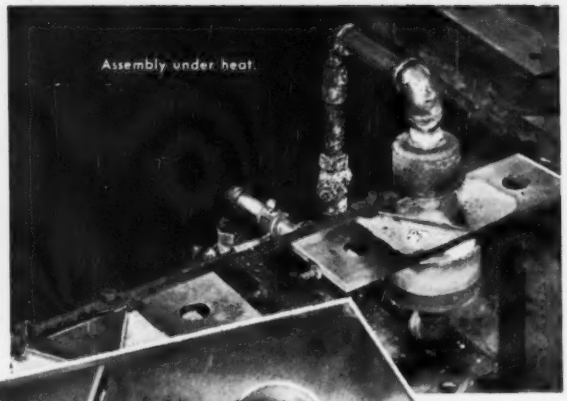


Three-part bus bar contact assembly; triangular piece, EASY-FLO shim and base plate.



Assembly under heat.

Note smooth, even fillet of completed assembly.

EASY-FLO "Moves in All Directions" to Braze Bus Bar Contact

Specialty Brazing Laboratory, Riverside, Connecticut, brazes, among other things, a bus bar contact for Rolock, Inc., Fairfield, Connecticut, makers of fabricated metal products. While a relatively simple assembly, it points up the remarkable *fluidity* of Handy & Harman Silver Brazing Alloys.

Both assembly components are copper. Base plate dimensions are ¼" x 8¾" x 2¾", and the ⅛" thick triangular piece is 3" on its base with 2⅞" sides.

After cleaning, the joint area of the base plate is HANDY-FLUXED and a shim of EASY-FLO 45 is placed on the base plate and the triangular piece set upon the shim. Heating by Selas gas-air burners is done on a 50-second cycle. Alloy cost is approximately four cents per assembly.

You'll notice, in the photo of the completed assembly, how smooth the alloy fillet is. The capillary action of EASY-FLO causes it to flow out in three directions, providing even joint penetration. This single fact (without going into the qualities of strength, conductivity, corrosion resistance, etc.) makes EASY-FLO a natural for electrical applications. Handy & Harman has, readily at hand, extensive data on the advantages of silver brazed joints for electrical applications. We are always ready and happy to discuss joining requirements and techniques with you. Your call or inquiry will bring complete and beneficial details.

FIRST, BULLETIN 20

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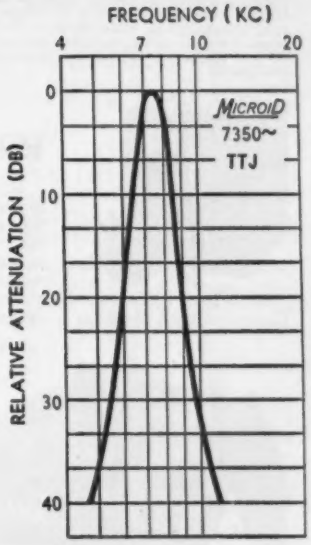
For example, as a low pass filter, Type TCLJ starts at 400 cps. Physical size is 11/16" x 1-11/16" x 1/2" max. For higher frequencies from 7,500 cycles up to 100 kc, size is 3/4" x 1" x 1/2".

The band pass filter, Type TTJ pictured here, ranges from 7,350 cycles up to 100 kc. Physical size is 1/2" x 19/32" x 15/16", weight .3 ounces, band width 15% at 3 db and + 60% − 40% at 40 db. Wherever space and performance are critical requirements, miniaturized *MICROID* ® low pass and band pass filters provide utmost reliability as well as more unit surface economy on printed circuit boards. Completely encapsulated, they are ideally suited to withstand high acceleration, shock and vibration environments. Write for special filter bulletin to help solve your circuit problems.

See these and other subminiature components on display at Booth 2919-2921, IRE Exhibit.



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NEW IN-CIRCUIT TRANSISTOR TESTER

Sierra 219A
Transistor Tester

The new Sierra Model 219A Transistor Tester provides a technical breakthrough —a means for in-circuit transistor testing, saving hours of trouble shooting and service time. Designed with a unique combination of transistor circuits, using low impedance methods, the Tester will measure the Beta parameter of a transistor while it is connected in a circuit. Beta and Collector Current parameters may be measured with the transistor removed from the circuit. Request Bulletin.

WAVE ANALYZERS

Model	Frequency Range—kc	Selectivity		Accuracy		Direct Reading in dbm	
		Down 3 db	Down 45 db	Frequency	Measuring	Balanced	Unbalanced
121A	15 KC-500 KC	± 100 cps	± 1000 cps	± 3 KC	± 2 db	Note D	600 ohms
158A	500 KC- 10 MC	± 2000 cps	± 5000 cps	± 0.08 MC	± 2 db	—	600 ohms
CARRIER FREQUENCY VOLTMETERS							
101C	20-500	± 550 cps	± 2900 cps	Note A	± 3 db	Note D	600 ohms
103B†	3- 40	± 400 cps	± 3000 cps	± 0.5 KC	± 3 db	Note D	600 ohms
104A	5-150	± 300 cps	± 1500 cps	± 1 KC	± 3 db	Note D	600 ohms
108B	15-500	± 550 cps	± 2900 cps	± 3 KC Note B	± 2 db Note C	135 ohms Note D	600 ohms
114A	100-800	± 550 cps	± 2900 cps	Note A	± 3 db	Note D	600 ohms
121Y	15-500	± 100 cps	± 1000 cps	± 3 KC	± 2 db	135,600Ω	—

All Sierra Carrier Frequency Voltmeters feature built-in calibration oscillators and circuits for level calibration, have aural monitoring jacks, and (except 103B) are furnished with Sierra Model 149A Precision Spiral Scale Dials. New Sierra 121Y CFVM, similar to Model 121A Analyzer but has special 20-pin connectors and selector switch for rapid patching to carrier racks.

†Contains carrier re-insertion oscillator for monitoring suppressed carrier systems. Furnished with planetary drive dial. Note A. Ranges from ± 2 KC at low end of dial to ± 3 KC at upper end. Note B. ± 1 KC in the 48 KC to 256 KC region. Note C. ± 1 db for + 30 db to —40 db attenuator steps on 135 ohm balanced measurements. Note D. All models may be converted for 135 and 600 ohm balanced line measurements by convenient plug-in bridging transformer, Model 130D.

WIDEBAND DIRECTIONAL COUPLERS

Model	10 KC	3 MC	10 MC	30 MC	100 MC	300 MC	1000 MC	2000 MC	Primary Line Connectors
137, 137A				73	63	53	43	37	Type N
138, 138A				59	49	39	29		Type N
145		52	42	32	22	12			Type N
150				53	43	33	23		Type N
212A				50	40				Type LC Female
213A				68	58	48			Type LC Female
214A					81	71			Type LC Female
139B	50	50							None

Directivity: 12 db ± 3 db greater than coupling factor at each frequency. e.g.: Model 145 at 100 MC has directivity of 34 db (22 + 12).

Impedance: Models 137 and 138 are 51.5 ohms. Models 137A, 138A, 145, 150, 212A, 213A and 214A are 50.0 ohms. Model 139B may be matched to most impedances encountered on open wire lines.

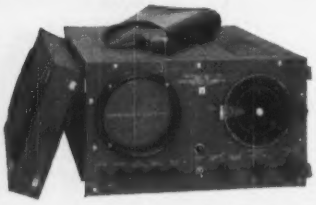
Power: Models 137, 137A, 138, 138A, 145, and 150 usable to 1000 watts. Models 212A, 213A and 214A usable to 150 KW peak. Model 139B usable to 50 KW or higher under certain conditions. See Bulletin 101.

Connectors: See table for primary line. Secondary line, type N, male, except 139B. Model 139B for open wire transmission lines.

Sierra 193A Ionization Gauge and 192A Amplifier

IONIZATION GAUGE & AMPLIFIER

Model 193A Ionization Gauge and Model 192A Ionization Gauge Amplifier provide convenient, dependable and accurate monitoring of pressures during processing from 10^{-4} to 10^{-9} mm Hg. Monel encased Phillips type ion gauges operate for months without attention; amplifier includes high voltage rf power supply, VTVM, heater transformer and low voltage supply. Request Bulletin 118.



Sierra 124A Line Fault Analyzer

LINE FAULT ANALYZER

Designed for rapid location of faults on cables, transmission lines. Instantly pin-points shorts, opens, grounds; indicates nature of fault as well as exact location. Easy to use, high resolution.

Model 124A Line Fault Analyzer operates on most OPEN WIRE power, communications lines. Direct reading, range ½ to 200 miles. Sweep marker continuously adjustable from 5 to 100 miles, locates faults with accuracy of ¼ mile. Request Bulletin 102.

IMPEDANCE METER

For high noise carrier measurements 30 KC to 300 KC. Measures on "hot" lines. Request Bulletin 112.

COAXIAL READOUT DEVICES

Increase Directional Coupler sensitivity, low VSWR, operates to 1,200 MC. 50 ohm impedance, filtered output. Request Bulletin

DOUBLE STUB TUNERS

Match 50 ohm line to loads having 2:1 VSWR. To 1.5 Kw peak; three models covering, collectively, 155 MC to 1,750 MC. Request Bulletin 110.

LINE BRIDGING TRANSFORMER

Converts voltmeter and wave analyzer inputs from single-ended to balanced operation. Model 130D bridges both 135 and 600 ohm balanced lines. Frequency range 3 KC to 500 KC. Write for details.

THERMOPILE

Converts differential temperatures in flowing liquids to electrical energy. Output approx. 1 mv/°C. Request Bulletin 119.

LOW PASS FILTERS

Model 184 Series Low Pass Filters have an insertion loss of not more than 0.4 db in pass band, sharp cut-off, 1.5 VSWR or less, and rejection greater than 60 db from 1.25 to 10 times cut-off frequency. Five models: for cut-off frequencies of 44, 76, 135, 230, 400 MC. Power range 250 watts in pass band, 25 watts in rejection band. Request Bulletin 115. *(Also higher frequency models. Request Bulletin M-23.)*

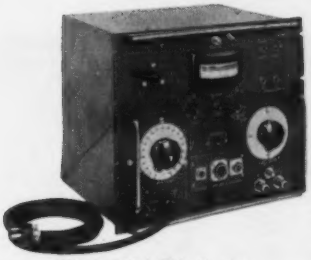
SIERRA ELECTRONIC CORPORATION

A Subsidiary of Philco Corporation

Sierra

TRADE MARK

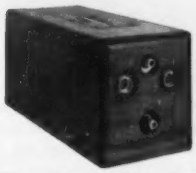
CALORIMETERS, WATER LOADS



Sierra 290A Calorimeter

Now Sierra offers two groups of Calorimeters and mating Water Loads for both waveguide and coaxial service.

Model 190 Calorimeter and Sierra XB187A/B Water Loads constitute a complete system for calorimetric power measurements in the SL, S, XB and X bands. Model 187 Water Loads are available with power measuring ranges of, respectively, 20 Kw, 10 Kw, 1 Kw and 2 Kw average. Request Bulletin M24. Model 190 Calorimeter has ranges of 300, 600, 1,500 and 3,000 watts max. A Coaxial Liquid Cooled Load, Sierra 186A-Z (not shown) can be used with 190 Calorimeters to measure dc to 4 MC. Request Bulletins.



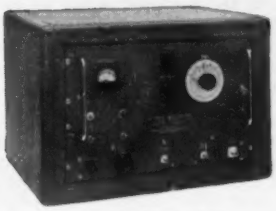
Sierra X287A Water Load

New Model 290A Calorimeter includes liquid flow controls, calibration sources and metering circuits. The calorimeter is self-calibrating and permits accuracies up to 1%. A closed loop circulating system with fluid pump and heat exchanger is available as an accessory. Request Bulletin.

Sierra X187B Water Load

New Model 287 series Dual Water Loads provide balanced measurements when used with Model 290A. 287 series loads are offered in SL, S, XB and X bands and, in conjunction with Model 290A, comprise a complete power measuring system. An unusual feature of the 287 series is that the thermopile is a part of the load, resulting in materially improved accuracy. Request Bulletin.

NEW POWER SOURCES— 25 MC TO 1,000 MC



Sierra 215A Power Source

New Model 215 Power Sources permit fast, accurate calibration of Bi-Directional Power Monitors and Termination Wattmeters. Output power is adjustable from 20% to 100% of rated power, and tuning is continuous over frequency ranges. Units are self-contained including power supply, and are supplied in sturdy bench cabinets or can be rack mounted. Four models cover, respectively, 25 MC to 50 MC, 50 MC to 150 MC, 150 MC to 470 MC and 470 MC to 1,000 MC. All models have an output of 50 watts ± 1.5 db; use Type N connectors and operate from a 115 v, 60 cps input. Request Bulletin M19.

50 OHM COAXIAL TERMINATIONS

New compact, light weight Model 160 series coaxial terminations feature stable operation over a wide frequency range and up to high ambient temperatures. High surface to volume ratio provide a very low VSWR from dc to 4,000 MC. Model 160—1: 1 watt; Model 160—5: 5 watts; Model 160—20: 20 watts; Model 160—100: 100 watts; Model 160—500: 500 watts. Request Bulletin 114.

FIELD, LAB POWER MEASURING INSTRUMENTS

TERMINATION WATTMETERS

Sierra 185A-15FN Termination Wattmeter

Sierra 185A Series Average-Reading Termination Wattmeters are broadly useful, dependable instruments for terminating rf coaxial transmission systems and measuring rf powers. They are ruggedly built, conservatively rated, and ideal as dummy loads for testing and adjusting transmitters and oscillators. Three models offer, respectively, power ranges of 0 to 5/15, 0 to 30/100 and 0 to 150/500 watts. Other specifications (all models): frequency range 20 to 1,000 MC, accuracy ±5%, maximum VSWR 1.2, female N connectors. Request Bulletin 120. (Sierra also offers Model 195A Peak Reading Wattmeters; request Bulletin 121.)

BI-DIRECTIONAL POWER MONITORS

Sierra 164 Power Monitor

Sierra offers Power Monitors whose collective frequency ranges provide coverage from 2 MC to 1,000 MC.

Model 164 Series (shown). Two plug-in elements cover 25 MC to 1,000 MC, measure incident and reflected power of 10, 50, 100 and 500 watts full scale. Another plug-in is similar but covers 2 MC to 30 MC. Also available are four lower power elements covering same range at 1, 5, 10 and 50 watts full scale. Power is read direct on linear scale accurate within ±5%. Insertion VSWR less than 1.08 (Type N connectors) except on 1 watt ranges where VSWR is 1.15. 50 ohm impedance. Model 164 with Type N or UHF connectors, male or female. Request Bulletin 111.

Model 194A-A Peak-Reading Power Monitor (not shown) measures incident and reflected peak power directly, 200 MC to 1,215 MC. 1, 3, 10 and 30 Kw peak, ±5% full scale. From 1μsec, 400 pps up. Request Bulletin 122.

PLUG-IN ELEMENTS FOR MODEL 164

(Note: Model 164 does not include plug-ins. Order separately as needed.)

180 Series—1, 5, 10, 50 watts full scale
180–52: 25 MC to 52 MC
180–148: 50 MC to 148 MC
180–470: 144 MC to 470 MC
180–1000: 460 MC to 1,000 MC

270 Series—50, 100, 500, 1,000 Watts full scale
270–75: 10 MC to 75 MC
270–30: 2 MC to 30 MC

181 Series—10, 50, 100, 500 watts full scale
181–250: 25 MC to 250 MC
181–1000: 200 MC to 1000 MC

Accessories Available: Model 164-LS Equivalent Transmission Line Section; Model 164-CC Carrying Case.

Model 194A-A Peak-Reading Power Monitor. Model 194A-A quickly measures incident and reflected powers on radar and other pulsed systems. Measures peak power directly, independently of duty cycle. 200 MC to 1,215 MC. 1, 3, 10 and 30 Kw peak. ±5% full scale. From 1 μsec pulses, 400 pps up. HN connectors. Request Bulletin 122.

Data subject to change without notice.

5442A BOHANNON DRIVE, MENLO PARK, CALIFORNIA, U. S. A.

Engineering Sales Representatives in all principal areas

Canada: Atlas Instrument Corp., Ltd., Toronto, Montreal, Vancouver, Winnipeg • Export: Frazar & Hansen, Ltd., San Francisco

KEARFOTT TACHOMETERS

...compact, light-weight, high-performance

Kearfott offers one of the broadest lines of precision tachometers in the industry. Light, compact and resistant to temperature, vibration and shock, they are available for a wide variety of applications.

Size 11 (R860)

Integrating Tachometers, special types of rate generators, are almost invariably provided integrally coupled to a motor. They feature tachometer generators of high output-to-null ratio and are temperature stabilized or compensated for highest accuracy integration, rate computation, etc. In addition to reducing the in-phase null level toward zero, errors due to temperature effects are minimized over a wide ambient range. Linearity, in some cases as low as .01%, is usually better than ±.1%, while phase shift is 0±1°. For extreme accuracy, models with low temperature coefficient drag cups are also available.

Rate Generators feature high output-to-null ratios and are designed for application as rate servos and to provide damping in very high gain systems. These Kearfott units offer high linearity, high output and low inertia and are often integrally coupled to a low inertia motor; in this design the in-phase null is virtually reduced to zero. Quadrature null is as low as .25% of the 1000 rpm outputs while harmonics seldom exceed .1% of the output at 1000 rpm.

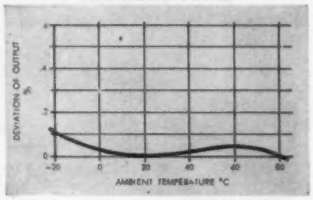
Damping Tachometers have relatively low output-to-null ratios and are designed primarily for damping purposes. They feature extremely low inertia and power consumption, linearity which is normally within ±.5%, and phase shift within 10° of reference. Kearfott damping tachometers are usually integrally coupled to a low inertia motor.

INTEGRATOR TACHOMETERS

(Typical Characteristics)

	Size 11 (R860)	Size 15 (T816)	Size 18 (V892)
Excitation Voltage (400 cps)	115	115	115
Volts at 0 rpm (RMS)	.020	.020	.010
Volts at 1000 rpm (RMS)	2.75	2.7	2.00
Phase shift at 3600 rpm	0°	0°	0°
Linearity at 0-3600 rpm	.07	.05	.07
Operating Temperature Range	−54° + 125°	−54° + 125°	−54° + 125°

TEMPERATURE

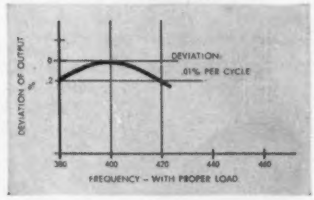


RATE TACHOMETERS | DAMPING TACHOMETERS

(Typical Characteristics)

	Size 15 (R800)	Size 18 (V806)	Size 8 (M824)	Size 10 (P822)	Size 11 (R809)
Excitation Voltage (400 cps)	115	115	26	115	115
Volts at 0 rpm (RMS)	.013	.026	.015	.019	.019
Volts at 1000 rpm (RMS)	3.1	3.0	.234	.450	.5
Phase shift at 3600 rpm	5°	4.5°	10°	5°	5°
Linearity at 0-3600 rpm	.25	.25	.3	.3	.3
Operating Temperature Range	−54° + 100°	−54° + 125°	−54° + 125°	−54° + 125°	−54° + 125°

FREQUENCY

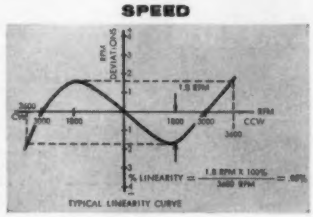


INTEGRAL SERVO MOTOR DATA

(Typical Characteristics)

	Size 8	Size 10	Size 11	Size 15	Size 18
No Load Speed (RPM)	5400	6600	5500	8000	8000
Stall Torque (oz. in.)	.3	.35	.55	.45	1.30
Excitation Voltage (400 cps)	18-40	26-40/20	115-40/20	115-40/20	115-115/57.5
Rotor Moment of Inertia (Gm.CM²)	1.3	.76	7.7	7.0	35
Operating Temperature Range	−54° + 100°	−54° + 125°	−54° + 125°	−54° + 125°	−54° + 125°
Unit Weight (incl. tachometer)—oz.	3.1	4.6	9.0	14.0	30

SPEED



Write for technical data

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.
A subsidiary of General Precision Equipment Corporation
Sales and Engineering Offices: 1378 Main Ave., Clifton, N. J.
Midwest Office: 23 W. Calendar Ave., La Grange, Ill.
South Central Office: 6211 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

Kearfott — A GENERAL PRECISION COMPANY

Merger Shows Growth Policy

ANNOUNCEMENT of merger plans between **Raytheon Manufacturing Co. and Machlett Laboratories,** Springdale, Conn., highlights an operational aspect of one large electronics firm that may set an example for others.

In January of this year, Raytheon president C. F. Adams announced his firm's intention to actively seek out and purchase small firms to bolster the growing pattern of the company.

Although policy statement did not reveal particulars regarding types of firms Raytheon wants, a company official told ELECTRONICS the trend of interest appears to be away from military oriented firms.

Raytheon currently relies on military orders for about 85 percent of company income. Interest in commercial product lines stems from Adams' wish to diversify income sources.

Machlett Laboratories leans in this direction. The firm has long been manufacturing x-ray tubes and is currently doing a brisk business in high-power tubes for operation at high voltages. Last year's sales hit the $10-million mark, with about 60 percent of the figure derived from commercial sales.

The trend towards commercially oriented firms became evident last year when Raytheon made its first purchase of a small firm, **Applied Electronics Co.** of San Francisco. Basic product line of Appelco is marine electronic gear for small craft and pleasure boats.

The new merger plans being studied call for an exchange of $19,106,500 in Raytheon stock for all 595,940 shares of Machlett stock now outstanding.

Breakdown of the $19 million in Raytheon stock includes $5 million in 5½ percent cumulative preferred stock at $50 par value. These stocks would be authorized for conversion any time within one year to Raytheon common stock at $66 a share. Remainder of the original $19 million would be made up on $14,106,500 in common stocks. Actual number of stocks involved will depend on the average market price of the issue during the first six months of next year.

Merger terms also stipulate that Machlett's stockholders will participate pro rata in all cash and stock dividends or splits occurring this year. A vote on the merger plans is slated for April 23. Stockholders of Machlett and Raytheon will be involved in the voting.

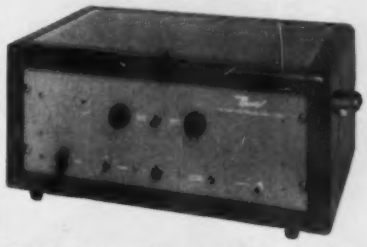
OVER THE COUNTER

1958 BIDS LOW	HIGH	COMMON STOCKS	WEEK ENDING Feb. 20 BID	Feb. 27 BID	ASKED
3¼	20½	Acoustica Assocs	23	22½	25⅛
1⅝	3	Advance Industries	3¼	3⅞	4⅛
3⅛	6⅝	Aerovox	7	6⅞	7⅛
20½	33	Amer Res & Dev	36¾	36½	38¼
16¾	24¼	AMP Inc	24½	28	29⅛
5½	15	Appl'd Sci Princet	11	12	13⅛
1⅛	8⅞	Avien, A	9½	8¾	10½
6¾	24	Baird-Atomic	26	26	28⅞
9¾	13⅜	Burndy	14⅝	16	18¾
6¾	9	Cohu Electronics	7	7	7⅝
11	22½	Collins Radio, A	23¾	26¾	29⅜
10¼	22¼	Collins Radio, B	23¾	26½	28⅞
4	7	Craig Systems	6¾	7¼	9⅛
30	50½	Dictaphone	40	44	49⅞
17⅜	25⅜	Eastern Industries	19	20	22¼
10½	21	Electro Instr	23	23¾	26½
34	49	Electronic Assocs	47½	44½	50⅜
5	11	Electronic Res'rch	12⅛	14¼	16¼
8½	12¾	Electronic Spec Co	13¼	12⅝	14⅛
15¼	49½	Epsco, Inc	36	33	38¾
5½	9⅜	Erie Resistor	10	10	11¼
10	17½	Fischer & Porter	15⅛	14¼	16½
36¾	50	Foxboro	49	49½	53½
5½	10½	G-L Electronics	13½	12½	15⅛
12	27	Gianninl	28	27½	30⅜
30	39½	Hewlett-Packard	38½	40¾	43¾
23¼	48	High Voltage Eng	53	54	59½
1¾	3	Hycon Mfg	3	3⅛	3⅝
1⅛	5⅛	Industro Trans'tor	2¾	2¾	3⅜
1½	4¾	Jerrold	4⅝	4¾	5½
21	30	D. S. Kennedy	32¾	31¾	35⅜
3¾	29	Lab For El'tronics	26½	27¼	37¼
19¼	28	Leeds & Northrup	27¾	28	30⅜
2	3⅛	Lextronics	2¼	2½	3¼
5	18¾	Ling Electronics	17¼	18⅝	20⅜
16	20½	Machlett Labs	24½	27½	30⅝
3¼	8¼	Magnetic Amplifiers	7⅝	7⅜	8½
2⅞	4½	Magnetics, Inc	3⅝	4	4⅜
4⅜	12	W. L. Maxson	13¾	12½	14⅜
10⅝	29	Microwave Assocs	31	29	33½
5¼	11¾	Midwestern Instr	13¾	13¾	15⅞
1⅛	7	Monogram Precis'n	8⅜	8⅝	10⅜
3½	7¼	Narda Microwave	7⅜	6⅞	8¼
9¾	16	National Company	19¼	21½	24⅝
14¼	56	Nuclear Chicago	32½	34	38¾
14½	29¾	Orradio Industries	30½	32	42
4½	7⅜	Pacific Mercury, A	10⅞	11⅛	12¼
10⅛	27½	Packard-Bell	33½	34	36⅛
4¼	5⅜	Panellit, Inc	6⅜	6½	8⅜
21	53¾	Perkin-Elmer	47	48¾	53
11⅜	19½	Radiation, A	18	18¼	20⅜
2⅛	7⅜	Reeves Soundcraft	6⅜	7⅜	8½
13	32½	Sanders Associates	28½	29½	34⅝
7	12	SoundScriber	17	15	18⅜
22¾	40	Sprague Electric	39	39	43
28	35	Taylor Instruments	32¼	34¾	38¼
5½	15	Technical Operat'ns	17¾	20	24⅛
5½	15¾	Telechrome Mfg	17	16¾	18⅞
3¼	7¾	Telecomputing	8½	8⅝	9½
1⅛	2¾	Tel-Instrument	2¾	2¾	3¼
8¾	16¼	Topp Industries	13¼	13¾	14½
3¾	10¾	Tracerlab	10¾	10¾	12¼
1⅛	3⅜	Universal Trans'tor	⅞	⅞	1¼
14¼	40	Varian Associates	42	45	53½
12½	18½	Vitro Corp. Amer	15⅞	15⅞	17¼

The above "bid" and "asked" prices prepared by the NATIONAL ASSOCIATION OF SECURITIES DEALERS, INC., do not represent actual transactions. They are a guide to the range within which these securities could have been sold (the "BID" price) or bought (the "ASKED" price) during preceding week.

NEW BENDIX

VOLTAGE-CONTROLLED OSCILLATOR FOR MISSILE & INDUSTRIAL APPLICATION



What it does: produces a pulsed output whose frequency is proportional to input voltage.

Where it can be used to advantage:

- Analog to FM telemetry.
- Driving FM data handling system directly from uncompensated potentiometer sensor.
- Converting EPUT meter to digital voltmeter.
- Providing 0.1% FM readout for voltage sensor.
- Acting as voltage integrator with cumulative counter.
- Checking response of pulse-averaging discriminators.
- As sweep frequency generator when driven by integrator-connected DC amplifier fed with square wave.
- As highly stable, variable frequency trigger source with input potentiometer.
- As reference element in wide band feedback discriminator.

Its performance characteristics:

Input Range	0 to +100 volts; d.c. to 1 KC.
Output Range	10 KC to 110 KC.
Output Pulse	0.5 μsec pulse, 0.1 μsec rise time. 80 volts amplitude, either polarity.
Linearity	Maximum deviation +0, −0.2% of full scale from straight line through 10 KC and 110 KC. May be corrected to best straight line giving maximum deviation of ±0.1% of full scale.
Frequency Response	Response to a step input of any amplitude is within one period of the state frequency corresponding to the step input.
Input Impedance	Greater than 1000 megohms at any input level.
Stability	Drift over a 24-hour period is 0.1% of full scale maximum after initial warm-up period.
Power	100-125 volts, 60 cycle.

For further information write to: Dept. J3-13

Cincinnati Division
Cincinnati, Ohio

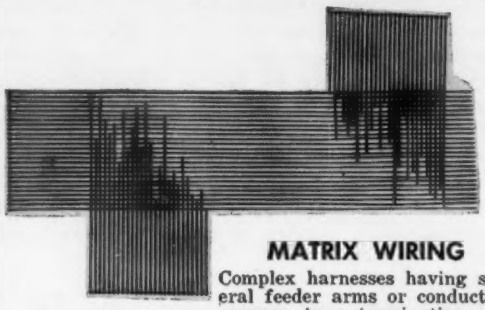
Bendix
AVIATION CORPORATION

CIRCLE 22 READERS SERVICE CARD

Simplified Cables and Harnesses produced by these new Flexprint® Wiring Techniques

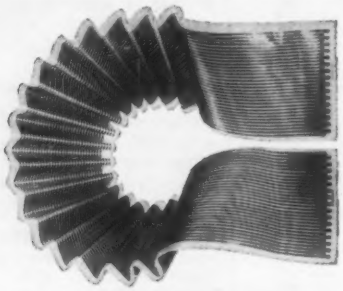
FLAT SHIELDED CABLE

Flexprint conductors are laminated between insulated ground planes. Choice of dielectric, spacing and shield configuration provides desired electrical characteristics with good flexibility. This technique also produces exceptionally light weight multi-conductor shielded cables, simulated twisted conductors and simulated coaxial cables.



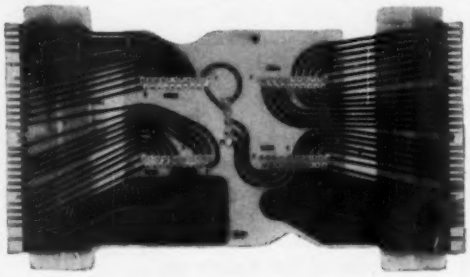
MATRIX WIRING

Complex harnesses having several feeder arms or conductors common to a termination, can be fabricated by the new spot-welded "T" forming technique. Fine conductors can be joined by this method to achieve a high density of interconnections. Crossing conductors are completely insulated.



PRE-FORMED CABLES

Flexprint cables can be pre-shaped to resist deformation or return to a desired shape after deformation. For example, this accordion-pleated *sliding drawer* cable for rack-mounted instruments stretches to permit withdrawal of equipment . . . folds neatly out of the way when drawer is closed.



REINFORCED CABLE

Flexprint cables and harnesses can be attached to rigid surfaces for extra strength and stiffness. Here, sections of the cable have been reinforced by bonding to epoxy board. Exposed copper conductors wrapped around the board's edge provide a standard printed circuit plug-in connection.

Can Sanders Flexprint Wiring simplify your complex Cables and Harnesses, too?

It will pay you to investigate! Using the new construction techniques illustrated above, Sanders can produce a wide variety of "3-dimensional" insulated printed flexible cables and harness. They have a combination of characteristics unmatched by ordinary wire and printed circuits.

Flexprint Wiring assemblies save up to 75% in weight . . . 65% in space . . . install in a fraction of the time required for conventional wiring . . . are available in insulations to meet your environmental requirements . . . have been used and approved in military equipment.

For complete details about capabilities, prices and deliveries, write or call today:

FLEXPRINT® PRODUCTS DIVISION

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Visit Booth 3842, I.R.E. Show

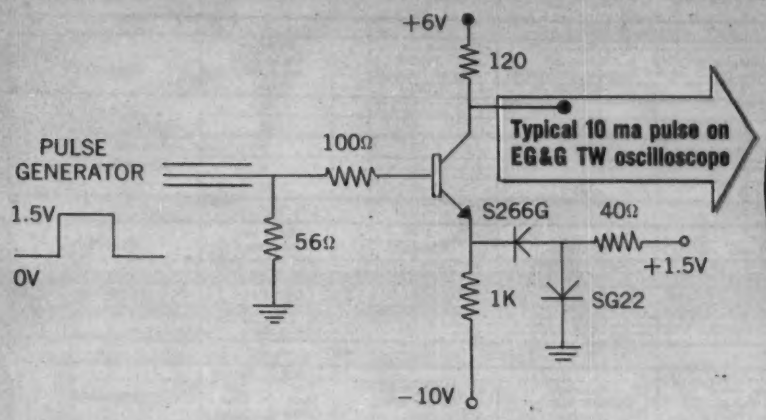
SANDERS ASSOCIATES, INC.

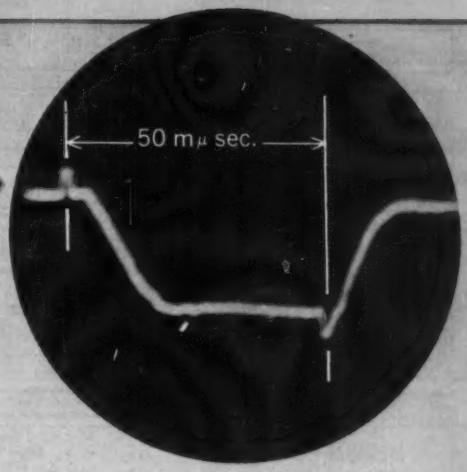
NASHUA, NEW HAMPSHIRE, *Dayton, Ohio; Inglewood, California; Washington, D.C.*

FIRST SILICON TRANSISTORS WITH

150 Mc Alpha Cutoff

PLUS POWER





ABSOLUTE MAXIMUM RATINGS

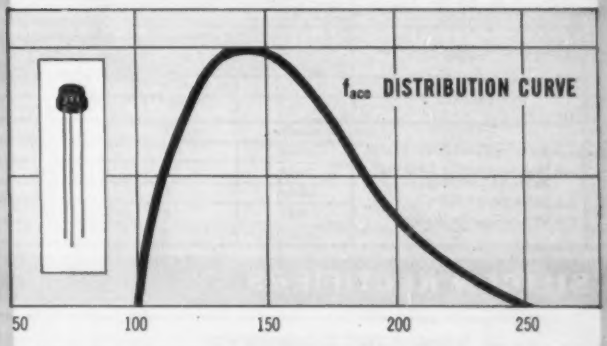
Collector to Emitter Voltage — V_{CE}	15 Volts
Collector to Base Voltage — V_{CB}	15 Volts
Emitter to Base Voltage — V_{EB}	3 Volts
Total Power Dissipation: at 125°C Case Temperature	.5 Watts
at 100°C Amb. Temperature	0.5 Watts

SPECIFICATIONS AND TYPICAL CHARACTERISTICS AT 25°C

		Min.	Typical	Max.	Test Conditions
D.C. Current Gain	h_{FE}	10	20	—	$I_C = 10ma$, $V_{CE} = 6V$
D.C. Collector Saturation Voltage	V_{CE}	—	.5	0.6V	$I_C = 10ma$, $I_B = 2ma$
Collector Cutoff Current	I_{CO}	—	2	5μa	V_{CB} = Rating
Output Capacitance	C_{ob}	—	8	12 μμf	$V_{CB} = 6V$, $I_E = 0$ mA
High Frequency Current Gain	h_{fe}	5	7.5	—	$F = 20mc$, $V_{CE} = 6V$ $I_E = 10$ mA
Delay Time	t_d	—	6	mμsec.	
Rise Time	t_r	—	12	mμsec.	
Fall Time	t_f	—	10	mμsec.	

Here's a silicon logic transistor with the speed of the fastest germanium types . . . PLUS POWER HANDLING ABILITY! Transitron's 2N1139 represents a giant step forward in transistor technology, augmenting the industry's most complete line of silicon transistors. Typical total switching times average less than 30 milli-microseconds.

Transitron's fast switching types now cover the entire current range up to 5 amperes — offer a rugged silicon transistor for every *switching* application.



TRANSISTORS • RECTIFIERS • DIODES • REGULATORS • VOLTAGE REFERENCES

Transitron

electronic corporation • wakefield, massachusetts

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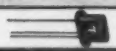
CIRCLE 24 READERS SERVICE CARD

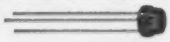
Transitron offers...

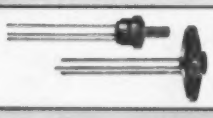
INDUSTRY'S MOST COMPLETE LINE

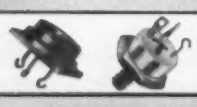
SILICON TRANSISTORS

JAN TRANSISTOR		Minimum Current Gain (B)	Maximum Collector Voltage (Volts)	Typical Cut-off Frequency (MC)	Maximum I_{co} @ 25°C and V_c Max. (μa)	FEATURES
	JAN-2N118	10	30	10	1	• Only Jan Silicon Transistor

SMALL SIGNAL		Minimum Current Gain (B)	Maximum Collector Voltage (Volts)	Typical Cut-off Frequency (MC)	Maximum I_{co} @ 25°C and V_c Max. (μa)	FEATURES
	2N333	18	45	7	50	• Low I_{co} • Operation to 175°C • 200 mw Power Dissipation
	2N335	37	45	10	50	
	2N480	40	45	11	.5	
	2N543	80	45	15	.5	
	ST905	36	30	10	10	

HIGH SPEED SWITCHING		Typical Cut-off Freq. (MC)	Maximum Collector Voltage (Volts)	Maximum Collection Saturation Resistance (ohms)	Max. Power Dissipation @ 100°C ambient (MW)	FEATURES
	2N1139	150	15	60	500	• High Frequency Operation • Low Saturation Resistance • Low I_{co}
	2N337	20	45	150	50	
	2N338	30	45	150	50	

MEDIUM POWER		Max. Power Dissipation @ 25°C Case (Watts)	Maximum Collector Voltage (Volts)	Minimum DC Current Gain (B)	Typical Rise Time (μsec)	Typical Fall Time (μsec)	FEATURES
	2N545	5	60	15	.3	.5	• Fast Switching • High V_c • Rugged Construction
	2N547	5	60	20			
	2N498	4	100	12			
	2N551	5	60	20			
	2N1140	3	40	20	.2	.1	

HIGH POWER		Maximum Power Dissipation .. 25°C Case (Watts)	Minimum DC Current Gain (B)	Typical Collector Saturation Resistance (Ohms)	Maximum Collector Voltage (Volts)	FEATURES
	ST410	85	15 @ 2 Amps	1.5 @ 2 Amps	60	• High Current Handling Ability • Low Saturation Resistance • Rugged Construction
	ST401	85	20 @ 2 Amps	1.5 @ 2 Amps	45	
	2N389	85	12 @ 1 Amp	3.5 @ 1 Amp	60	
	2N424	85	12 @ 1 Amp	6.0 @ 1 Amp	80	

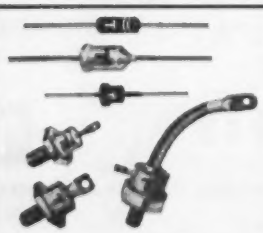
Write for Bulletins: TE-1353 and TE-1355

SILICON DIODES

	Fast Switching and High Frequency Types Ratings @ 25°C				Military and High Conductance Types Ratings @ 150°C			
FEATURES		Max. Inverse Voltage (Volts)	Max. Average Fwd. Current, (ma)	Inverse Recovery Time (μsec)		Max. Inverse Voltage (Volts)	Max. Average Fwd. Current (ma)	Max. Inverse Current (μa) @ V
• Recovery Times Under 15 μsec • High Conductance Combined With Fast Switching • Subminiature Size • High Inverse Resistance	1N808	100	100	.3	JAN 1N457	60	25	5 @ 60
	1N809	200	100	.3	JAN 1N458	125	25	5 @ 125
	1N658	120	200	.3	JAN 1N459	175	25	5 @ 175
	1N659	55	100	.3	1N485B	180	50	5 @ 175
	1N643	110	100	.3	1N488A	380	50	25 @ 380
	JAN 1N251	30	75	.15	1N464	175	40	30 @ 125

Write for Bulletin TE-1350

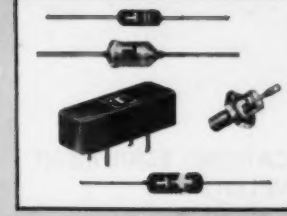
SILICON RECTIFIERS

Ratings @ 150°C Case Temperature			Peak Recurrent Inverse Voltage (Volts)	Maximum Average Forward Current (ma)	Maximum Inverse Current (ma)	FEATURES
	Subminiature Glass	1N689 1N649	600 600	150 150	0.2 0.2 (@ 25°C)	• Reliability at High Temperatures • High Efficiency • Rugged Construction • Hermetic Sealing • Low Thermal Resistance
	Miniature	TJ60A TJ30A	600 300	200 200	0.5 0.5	
	Axial Leads	SL715 1N547	1500 600	100 250	0.2 0.3	
	Military	JAN 1N256	570	200	0.25 (@ 135°C)	
	Stud Mounted	TM155 TM67	1500 600	400 3000	0.5 0.5	
	Medium Power	TR402 TR601	400 600	Amps 20 10	5 5	
	High Power	TH402B	400	50	15	

CIRCLE 25 READERS SERVICE CARD

Write for Bulletin TE-1351

SILICON REGULATORS AND REFERENCES



	Voltage Range (Volts)	Maximum Dynamic Resistance (ohms)	Maximum Current @ 25°C (ma)	Maximum Current @ 125°C (ma)	FEATURES
Subminiature — SV-5	4.3-5.4	55	50	10	• Long-term stability • Operation up to 150°C • Small size, easy mounting • Hermetically sealed
Miniature — SV-815	13.5-18	120	40	8	
Power — SV-924	20-27	8	55°C (amps)* .4	(ma)* 100	
Stabistor — SG-22	.64	40	150	25	
Reference — SV-3176	8-8.8	15	Temp. Coefficient ≐.001%/°C		
Ref-Amp — 3N44	8.3-9.8		≐.002%/°C		

*Case temperature ratings

Write for Bulletin TE-1352

SILICON CAPACITORS

	Ultra High Frequency Types — Ratings @ 25°C						FEATURES
	Cut-off Freq. (mc)	Capacity (μμf) @ V Max.	Capacity (μμf) @ −0.1V	Q @ −4V @ 50Mc	Q @ −4V @ 100Mc	Maximum Working Voltage	
SCH-51	5000	.35	2	100	50	10	• Subminiature Size • High Q • High Temperature Operation
SCH-52	5000	.8	4	100	50	7	

	High Frequency Types				
				Q @ −4V At 5mc	At 50mc
SC-1		4.4	24	350	35	22
SC-5		25	120	350	35	11
SC-15		120	360	350	35	6

GERMANIUM DIODES

Write for Bulletin PB-45

Specifications and Ratings at 25°C		Forward Current @ +1V (ma)	Inverse Current at Specified Voltage (μa @ V)	Max. Oper. Voltage (volts)	Description
	JAN-1N270	200	100 @ −50	80	JAN TYPES
	JAN-1N277	100	250 @ −50 @ 75°C 75 @ −10	100	
	JAN-1N281	40	500 @ −50 30 @ −50	60	
	JAN-1N126	5	500 @ −50 30 @ −10	60	
	JAN-1N198	5	250 @ −50 @ 75°C 75 @ −10	50	
	1N283	200	20 @ −10	20	COMPUTER TYPES
	T16G	40	100 @ −50	60	
FEATURES • Milli Microsecond Switching • Superior Forward Conductance • High Inverse Resistance • Uniformity and Stability • Gold Bonded Construction	1N278	20	125 @ −50 @ 75°C	50	HI-TEMPERATURE TYPES
	T22G	40	20 @ −10 @ 75°C	15	
	T9G	100	20 @ −50 2 @ −10	60	HI-RESISTANCE TYPES
	1N67A	5	50 @ −50 5 @ −5	80	
	T8G	100	20 @ −100 5 @ −10	100	
	S570G	10	30 @ 6	Recovery Time .002 (μsec)	MILLI-MICROSECOND SWITCHING

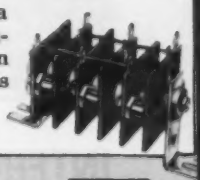
GERMANIUM COMPUTER TRANSISTORS

Write for Bulletin TE-1300 & TE-1319

	Minimum Current Gain (B)	Maximum Collector Voltage (volts)	Typical Cutoff Freq. (MC)	FEATURES
2N427	40	15	8	• High FrequencySwitching • Low Saturation Resistance • Uniform Input Characteristics
2N428	60	12	13	

Your local authorized TRANSITRON DISTRIBUTOR now carries in-stock inventories for immediate delivery.

Transitron's TD series of rectifier stacks offer a wide range of ratings in seven standard circuit configurations. High voltage cartridges, quads, plug-in assemblies, and many other special encapsulations are also available. Your inquiries are invited.
Write for Bulletin TE-1342.



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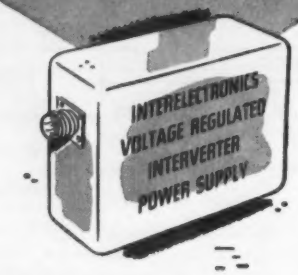
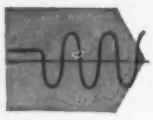
CIRCLE 26 READERS SERVICE CARD

NEW!

DC to DC and DC to AC solid-state power converters voltage regulated, frequency controlled, for missiles, telemetering, gyros, servos





Interelectronics inverter solid-state thyratron-like elements and magnetic components convert DC to any number of voltage regulated or controlled frequency AC or filtered DC outputs from 1 to 1800 watts. Light weight, compact, 90% or better conversion efficiency.

Ultra-reliable in operation, no moving parts, unharmed by shorting output or reversing input polarity. Complies with MIL specs for shock, acceleration, vibration, temperature, RF noise.

Now in use in major missiles, powering telemetering transmitters, radar beacons, electronic equipment. Single and polyphase AC output units now power airborne and marine missile gyros, synchros, servos, magnetic amplifiers.

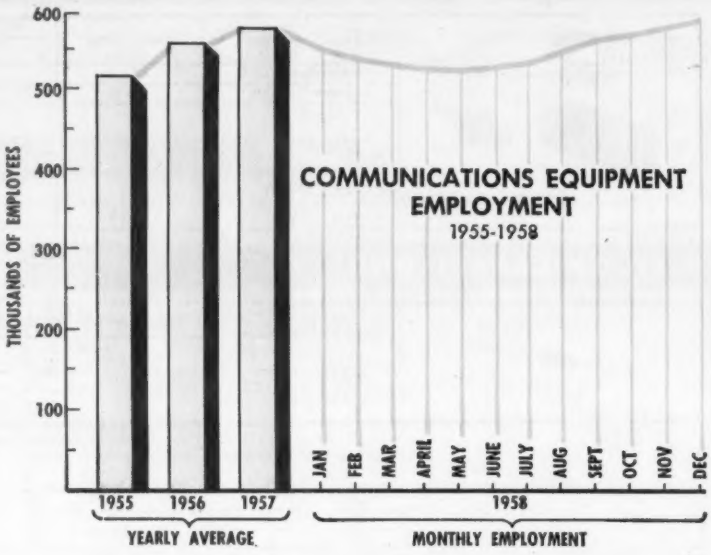
Interelectronics — first and most experienced in the DC input solid-state power supply field, produces its own solid-state gating elements, all magnetic components, has the most complete facilities and know-how—has designed and delivered more working KVA than any other firm!

For complete engineering data write Interelectronics today, or call LUdlow 4-6200 in N. Y.

INTERELECTRONICS CORPORATION

2432 GR. CONCOURSE, N. Y. 58, N. Y.

CIRCLE 27 READERS SERVICE CARD



Communications Hiring Up

EMPLOYMENT of all communication equipment workers continues to climb.

Examination of 1958 second half employment record shows definite recovery from recession's effects. Number of employees rose steadily from July, 1958, to a peak level in December of 589,500 persons—approximately 21,000 higher than for the last month of 1957.

Average total in 1958 of all communication equipment employees was 551,700; 1957 average was 579,800 workers; 1956, 557,800.

Production workers in the communicaton equipment group showed similar improvement during final third of 1958. December record of 379,900 persons employed represents a rise to within 500 of 1957's final month total.

• **Marketing appointments: Victor C. Houk,** manager, market planning, Industrial Tube Products department, RCA Electron Tube division; **James K. Dysart,** vice president, marketing, Leach Corporation; **Carl A. Wagner,** director of marketing and advertising, Cleveland Controls, Inc.

• **Reader interest** in Market Research story, "Special-Tube Sales Rising" (ELECTRONICS, p 20, Jan. 9), has prompted further research into industrial and special-purpose tube market. Total estimated sales figures for 1958 and 1959 have been changed slightly in light of more recent information.

Roundup of factory tube sales:

$ Millions	1958	1959
Ignitrons	1.8	2.3
Thyratrons	4.5	5.0
Klystrons	30.0	37.0
Magnetrons, Fixed	34.0	40.0
Magnetrons, Tunable	22.0	25.0
Switching Tubes	5.5	6.3
High Vac. Diodes	5.4	5.8
Gas & Vapor Diodes	3.2	4.0
Trav. Wave Tubes	6.1	7.5
Light Emitting & Light Sensitive	18.0	20.0
Multigrids, Int. Anode	10.5	12.0
Multigrids, Ext. Anode	19.5	22.0
X-Ray	8.0	8.2
Misc.	5.0	7.0
	$173.5	$202.1

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Feb. 20, 1959	Jan. 23, 1959	Change From One Year Ago
Television sets	115,909	112,762	+33.4%
Radio sets (ex. auto)	273,854	293,721	+42.3%
Auto sets	106,066	108,359	+49.8%

STOCK PRICE AVERAGES

(Standard & Poor's)	Feb. 25, 1959	Jan. 28, 1959	Change From One Year Ago
Electronics mfrs.	76.18	73.04	+45.6%
Radio & tv mfrs.	86.66	79.08	+91.1%
Broadcasters	84.25	81.24	+52.2%

Digital Computer Techniques—*State of the Art*

Failure of computers has been known to force scientists back to more primitive forms of calculation. (Note the extra digit which comes in handy when numerical concepts need to be "carried".) However, at Hughes, we have developed and are producing components which insure you against breakdown even under the most severe operational conditions. Our most powerful ally is an almost unreasonable passion for quality control.

On the following three pages you'll find specific examples of Hughes *reliable* components—Parametric Amplifier Diodes, TONOTRON* Storage Tubes, and MEMO-SCOPE® Oscilloscopes.

In addition to these, other Hughes Products devices which offer you this "built-in" reliability include: Precision Crystal Filters for selective tuning...Rotary Switches...Thermal Relays... MEMOTRON® and TYPOTRON® Storage Tubes... Microwave tubes...Diodes, Transistors and Rectifiers with uniform performance...and Industrial Systems which automate a complete and integrated line of machine tools.

*Trademark of H.A.C.

I.R.E. SHOW: See the Hughes Exhibits Number 2801-2807.

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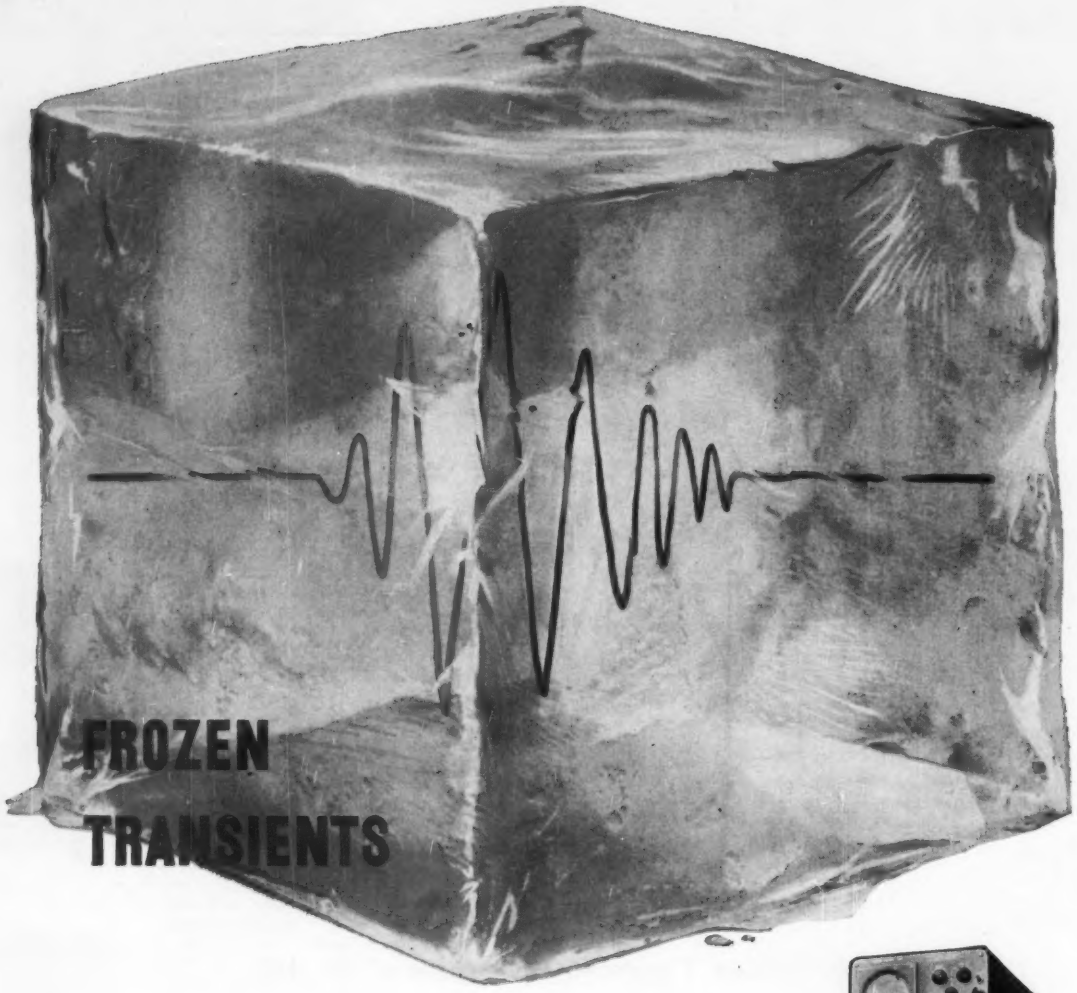
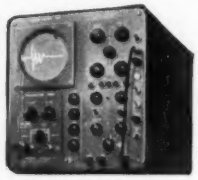


with the Hughes MEMO-SCOPE® Oscilloscope



Trial and error methods necessary to capture elusive transients on conventional scopes waste time, film, and precious research dollars. Never again need this happen. With the Hughes MEMO-SCOPE® oscilloscope you may instantly "freeze" wave forms with brilliant clarity for careful study, comparison and analysis.

The Hughes MEMO-SCOPE® oscilloscope retains these frozen transients until intentionally erased. Selected transient information may be triggered externally or internally. Successive wave forms may be written above, below or directly over the original information.

SWEEP SPEED FOR STORAGE: 10 microseconds to 10 seconds per division (0.33").

FREQUENCY RESPONSE: DC to 250 KC down 3 db.

SENSITIVITY: 10 millivolts to 50 volts per division or with optional high sensitivity preamplifier 1 millivolt to 50 volts per division.

APPLICATIONS: Trouble shooting data reduction equipment . . . switch and relay contact study . . . ballistics and explosives research . . . ultrasonic flaw detection . . . physical testing — shock — stress — strain.

A Hughes representative will gladly demonstrate the MEMO-SCOPE® *oscilloscope in your company. Simply address your request to: Hughes Products, Marketing Dept.—*MEMO-SCOPE®
International Airport Station, Los Angeles 45, California

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AN IMPORTANT NEW PRODUCT ANNOUNCEMENT FROM HUGHES!

PARAMETRIC AMPLIFIER DIODES

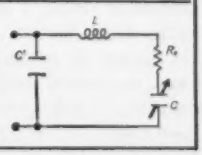
FOR LOW-NOISE MICROWAVE AMPLIFIERS

Now Hughes Products brings you high performance parametric amplifier diodes at a price in the same range as good microwave mixer crystals. These Hughes diodes have been designed to solve your problems associated with low-noise parametric amplifiers, modulators, frequency converters, harmonic generators, electronic tuners, switches, etc., at microwave as well as at lower frequencies.

Used in a 3000 Mc high gain parametric amplifier with both signal and idler channels as inputs, these diodes have produced at room temperature in the laboratory a noise temperature of 100°K above absolute zero. Noise temperatures of 50°K above absolute zero were obtained when diode was cooled by liquid nitrogen.

The Hughes Parametric Amplifier Diodes are available in two rugged, hermetically sealed versions. One has a miniaturized glass package (type HPA 2800); the other has been adapted to a conventional microwave package (type HPA 2810). Both are hermetically sealed in glass and have the same cutoff frequency.

TECHNICAL SPECIFICATIONS AND DATA:

Package (actual size)	C'	C @ zero bias (nominal)	cutoff frequency* (nominal)	L (nominal)	V_S** Min.	V_S** Nom.	Equivalent Circuit
HPA 2800	0.1 $\mu\mu$f	2.5 $\mu\mu$f	70KMC	4 mμh @ 1KMC	5V	7V	
HPA 2810	0.2 $\mu\mu$f						

*At breakdown voltage **Breakdown voltage (10 μA point)

CAPACITANCE vs. BIAS VOLTAGE	Reverse Bias Voltage	Capacitance C
	0 V	2.5 $\mu\mu$f
	3 V	0.76 $\mu\mu$f
	7 V	0.60 $\mu\mu$f

Address inquiries to:
Hughes Products, Semiconductor Marketing Dept., P. O. Box 278, Newport Beach, California.

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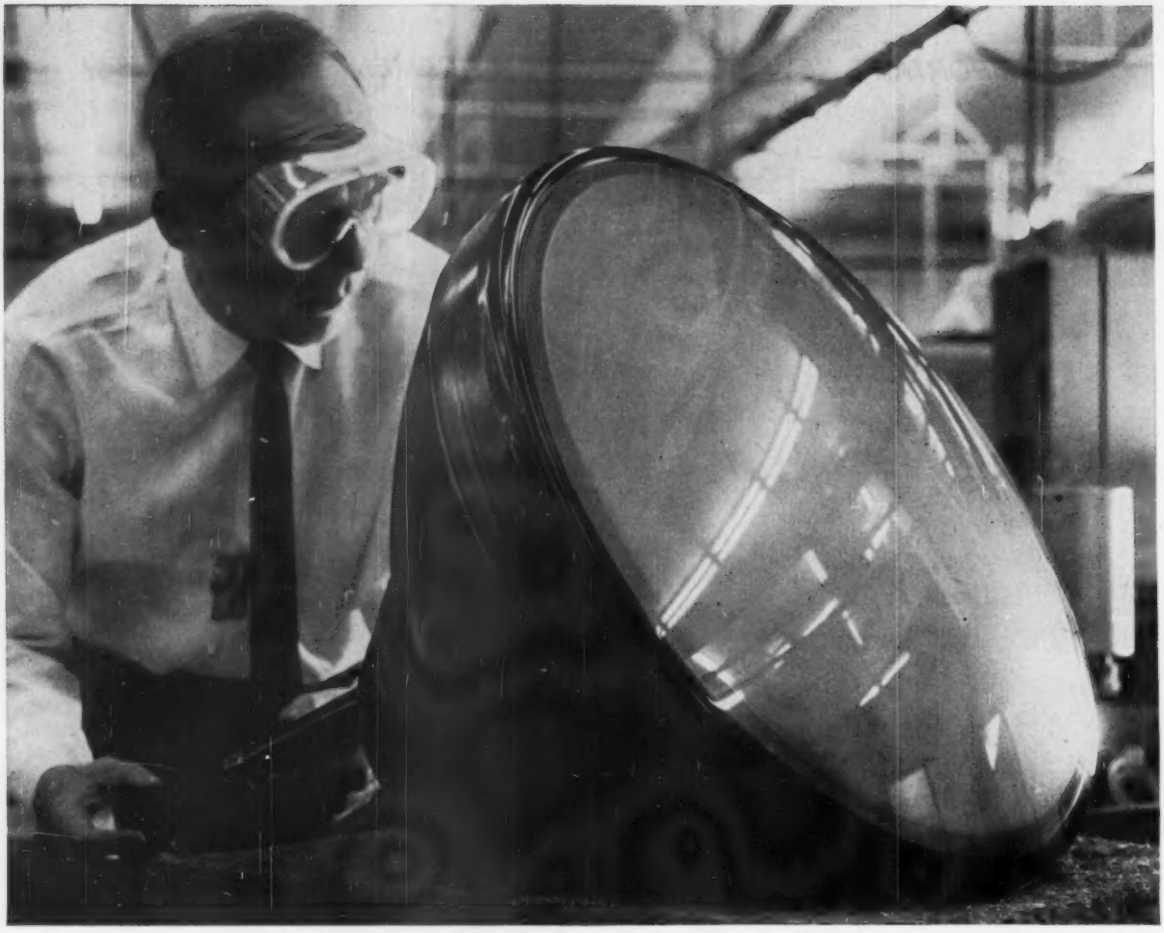

THE FIRST 21" STORAGE TUBE

High light output! Controlled Persistence! Full gray scale!

The Hughes 21" TONOTRON* tube offers you a new level of sophistication in displays for: Air traffic control, Combat situation plotting, Radars, Large-scale read-out, Medical diagnosis, Industrial television, and Slow-scan displays.

This new TONOTRON tube provides high light output, integration abilities, full gray scale, controllable persistence, and a very large display area—all in one envelope!

Hughes also announces a 21" character-writing TYPOTRON* storage tube, which gives you the *added* capability of high-speed digital character display. The 21" TYPOTRON tube is ideally suited for any of your digital read-out requirements. In addition, this unique TYPOTRON tube offers you either character read-out or spot writing modes—or a combination of both capabilities.

Both the 21" TONOTRON Tube and the 21" TYPOTRON tube are now available for delivery. For additional information please write: Hughes Products, Electron Tubes, International Airport Station, Los Angeles 45, California.

See the new Hughes 21" TONOTRON tube in action at the I.R.E. show (Booths 2801-2807)

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We promise you will receive a reply within one week!

NEW OPENINGS AT HUGHES RESEARCH & DEVELOPMENT LABORATORIES

Hughes has several hundred openings for engineeers and physicists whose training and experience are applicable to the research, development, design and testing of airborne electronic equipment for use in supersonic military aircraft; in solid state physics, nuclear electronics, industrial dynamics, and related areas.

Use of the following form will, we hope, reduce to a minimum the inconvenience of submitting an employment inquiry, yet will still permit us to give you a reasonably definitive reply.

Please airmail to:
Mr. Robert A. Martin, Supervisor, Scientific Employment
Hughes Research and Development Laboratories
Culver City, California

HUGHES

*Name*_____

*Address*_____

*City*_____ *Zone*_____ *State*_____

*College*_____ *Degree*_____ *Year*_____

I am interested in one of the following types of assignment:

☐ RESEARCH ☐ PRODUCT ENGINEERING ☐ SYSTEMS ☐ OTHER:_____
☐ DEVELOPMENT ☐ TECH. ADMIN. ☐ FIELD TEST ☐ _____

I have had professional experience in the following specific areas:

☐ CIRCUIT ANALYSIS AND DESIGN ☐ STRESS ANALYSIS ☐ R-F CIRCUITS ☐ ELECTRO-MECHANICAL DESIGN
☐ DIGITAL COMPUTERS ☐ INDUSTRIAL DYNAMICS ☐ RELIABILITY ☐ OTHER:_____
☐ GUIDANCE DEVICES ☐ MATERIALS ☐ ATOMIC AND/OR SOLID STATE PHYSICS ☐ _____
☐ MICROWAVES ☐ SYSTEMS ANALYSIS ☐ INSTRUMENTATION ☐ _____

I have had a total of _____ years of experience.

How to help your customers COUNTrol their production

Do your customers complain of spotty production . . . short-runs, over-runs, uncertain quality control, uneven performance from your machine or product? If so, there's one thing you can do about it . . . build a Veeder-Root Counter into your product as a standard integral part. Then you can offer your customers constant visual *Count*rol of your product's performance . . . which amounts to recorded proof of your product's guarantee.

You'll find, too, that built-in counters build up sales. And you can count on us to "teach your product to count". Write.

You always "Know the score" when you count on Veeder-Root!

NEW "VISICOUNTER'

Gives greater figure-visibility with dome-shaped window. Better suited for panel mounting. This rugged, heavy duty counter comes in both ratchet and geared types. 6 non-overthrow wheels. 1-piece case.

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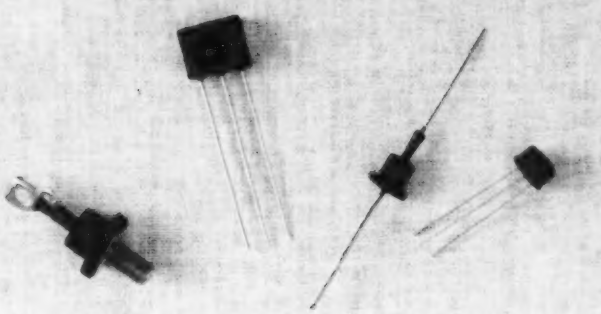
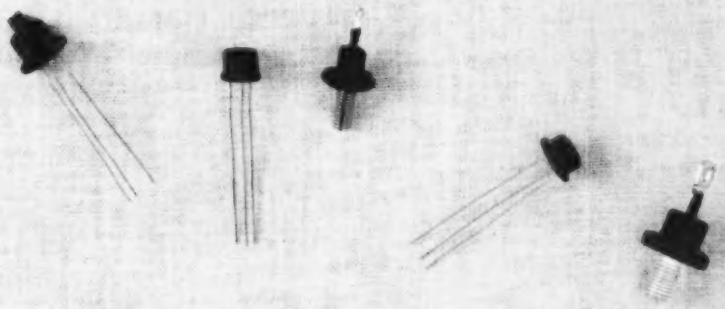
CIRCLE 33 READERS SERVICE CARD

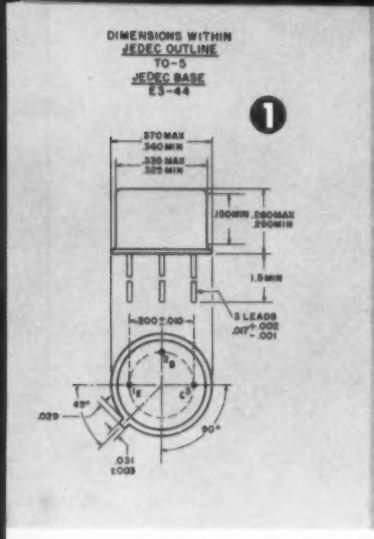
CIRCLE 34 READERS SERVICE CARD→

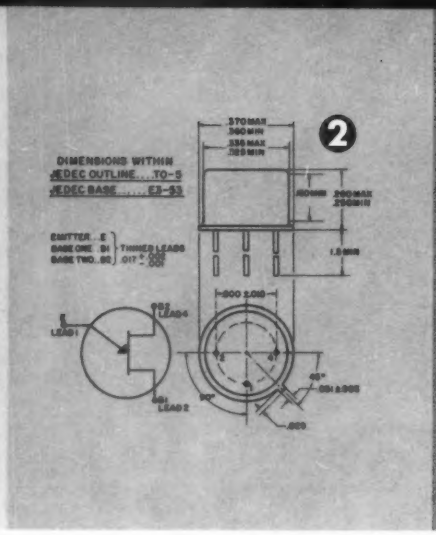


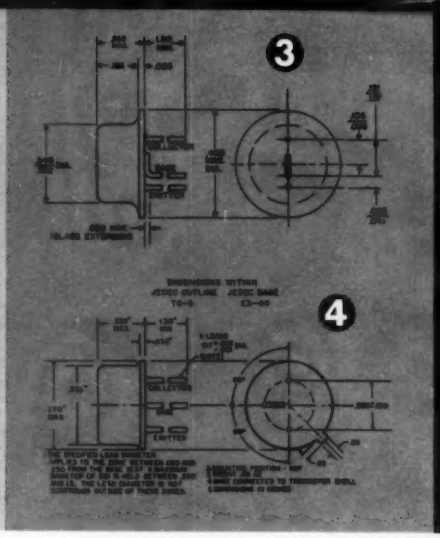


SEMICONDUCTORS

Transistors ● Rectifiers ● Germanium ● Silicon ● Selenium ● Copper Oxide ● Unijunctions ● Controlled Rectifiers ● Fixed-bed Mounting ● USAF ● JAN ● USN ● Low Frequency Audio and Switching ● High Frequency Switching ● Low-Medium-High Current ● High and Low Temperature







TRANSISTORS Germanium • Silicon • Fixed-Bed Mounting • Unijunctions • Tetrodes • High Frequency Switching • Low Frequency Audio and Switching • USAF

NEW TECHNOLOGY

As a result of recent technology advancements in such areas as product engineering, manufacturing-line processing, and quality-control systeming, General Electric Company again offers you the *avant garde* in present-day transistor quality.

EXAMPLES

PNP low-frequency survival records have been shattered by the accomplishment of one-million unit-hours of life survival with the G-E 2N43A transistor.

Higher gain and improved saturation characteristics have been created for high-frequency switching. This was brought about by G.E. through recent improvements in d-c beta at higher collector currents, made with Types 2N123 and 2N450 transistors.

With a collector current of 1½ μa max. at 15 volts, G.E.'s germanium NPN high-frequency 2N167 gives an ultimate in I_{co}. It also has a low collector capacitance of 3 $\mu\mu$f.

The mechanically rugged golf-club/shotgun-tested ceramic fixed-bed transistor mounting has been expanded, product-wise, beyond the Series 2N489-494 unijunction line, and is now also offered in the NPN high-frequency transistor series (2N332-338).

MILITARY TYPES

G-E quality advances are also exhibited by General Electric's over-all success in supplying to an increasing number of military specifications covering semiconductor products. G-E MIL transistors include the USAF-types 2N43A, 2N44A, and 2N167. The G-E Types 2N123A and 2N396A are certified to meet military specs. (See adjacent rating chart.) For G-E military rectifiers, see next two fold-out pages.

ADDITIONAL INFORMATION

For more-detailed information, please contact your nearest G-E Semiconductor Products District Representative. (See back page.)

	USE	OUTLINE DWG. NO.	TYPE NO.	
SILICON	AMPLIFIER AND COMPUTER NPN (Ceramic Fixed-bed Construction)	1	2N332	
		1	2N333	
		1	2N334	
		1	2N335	
		1	2N336	
		1	2N337	
		1	2N338	
	UNIJUNCTION NPN (Ceramic Fixed-bed Construction)			
		2	2N489*	
		2	2N490*	
		2	2N491*	
		2	2N492*	
		2	2N493*	
		2	2N494*	
			*A PN Device	
GERMANIUM	AUDIO PNP	3	2N43	
		3	(USAF) 2N43A	Per MIL-T-19500/18
		3	2N44	
		3	(USAF) 2N44A	Per MIL-T-19500/6
		4	2N524	
		4	2N525	
		4	2N526*	
		4	2N527	
			*Also supplied as certified to meet MIL-T-19500/60	
	COMPUTER PNP	5	2N123	
		5	2N123A	Certified to meet MIL-T-19500/30
		4	2N395	
		4	2N396	
		4	2N396A	Certified to meet MIL-T-19500/64
		4	2N397	
		4	2N404	
		5	2N450	
		5	2N518	
		3	2N1056	
		3	2N1057	
	HIGH FREQ. AMLIFIER NPN	6	2N78	
		6	2N169A	
	COMPUTER NPN	6	2N167	
		6	(USAF) 2N167	Per MIL-T-19500/11
		4	2N634	
		4	2N635	
		4	2N636	
	TETRODE NPN	7	3N36	
		7	3N37	

RECTIFIERS! Fold out next page ▶

RECTIFIERS Germanium • Silicon • High and Low Temperature • Controlled Rectifiers Low-Medium-High Current • JAN • USN • USAF

BASIC RATING CHART

Choose the performance range required for your particular needs from one of the most comprehensive line of rectifiers in the industry. Complete specifications are available through your distributor or G-E Semiconductor Products District Sales Office. Order by JEDEC or G-E Type No.

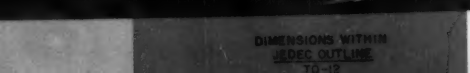
RECTIFIER CELLS

JEDEC or G-E Type No.	PIV	Max. I_{DC} at T°C	Max. 1 Cycle (60 cps) Surge	Max. Oper. Temp. °C	Max. Storage Temp. °C
1N91	100	150ma at 55° amb.	25A	95°	85°
1N92	200	100ma at 55° amb.	25A	95°	85°
1N93	300	75ma at 55° amb.	25A	95°	85°
USN1N93	300	75ma at 55° amb.	25A	55°	85°
1N151	100	500ma at 55° amb.	25A	95°	85°
1N152	200	500ma at 55° amb.	25A	95°	85°
1N153	300	500ma at 55° amb.	25A	95°	85°
1N158	380	500ma at 55° amb.	25A	95°	85°
1N253	95	1000ma at 135° stud	4A	150°	150°
1N254	190	400ma at 135° stud	1.5A	150°	150°
1N255	380	400ma at 135° stud	1.5A	150°	150°
1N256	570	200ma at 135° stud	1.5A	150°	150°
1N315	100	100ma at 85° amb.	5A	85°	95°
USAF1N315	100	100ma at 85° amb.	5A	85°	100°
1N332	400	400ma at 150° stud	15A	170°	170°
1N333	400	200ma at 150° stud	10A	170°	170°
1N334	300	400ma at 150° stud	15A	170°	170°
1N335	300	200ma at 150° stud	10A	170°	170°
1N336	200	400ma at 150° stud	15A	170°	170°
1N337	200	200ma at 150° stud	10A	170°	170°
1N339	100	400ma at 150° stud	15A	170°	170°
1N340	100	200ma at 150° stud	10A	170°	170°
1N341	400	400ma at 150° stud	15A	170°	170°
1N342	400	200ma at 150° stud	10A	170°	170°
1N343	300	400ma at 150° stud	15A	170°	170°
1N344	300	200ma at 150° stud	10A	170°	170°
1N345	200	400ma at 150° stud	15A	170°	170°
1N346	200	200ma at 150° stud	10A	170°	170°
1N348	100	400ma at 150° stud	15A	170°	170°
1N349	100	200ma at 150° stud	10A	170°	170°
1N368	200	100ma at 85° amb.	10A	65°	85°
1N440	100	300ma at 100° amb.	15A	150°	175°
1N440B	100	500ma at 100° amb.	15A	165°	175°
1N441	200	300ma at 100° amb.	15A	150°	175°
1N441B	200	500ma at 100° amb.	15A	165°	175°
1N442	300	300ma at 100° amb.	15A	150°	175°
1N442B	300	500ma at 100° amb.	15A	165°	175°
1N443	400	300ma at 100° amb.	15A	150°	175°
1N443B	400	500ma at 100° amb.	15A	165°	175°
1N444	500	300ma at 100° amb.	15A	150°	175°
1N444B	500	425ma at 100° amb.	15A	150°	175°
1N445	600	300ma at 100° amb.	15A	150°	175°
1N445B	600	350ma at 100° amb.	15A	150°	175°
1N536	50	500ma at 100° amb.	15A	165°	175°
1N537	100	500ma at 100° amb.	15A	165°	175°
1N538	200	500ma at 100° amb.	15A	165°	175°
USAF1N538	200	500ma at 100° amb.	15A	150°	175°
1N539	300	500ma at 100° amb.	15A	165°	175°
1N540	400	500ma at 100° amb.	15A	165°	175°
USAF1N540	400	500ma at 100° amb.	15A	150°	175°
1N547	600	500ma at 100° amb.	15A	165°	175°
1N550	100	800ma at 135° stud	15A	150°	175°
1N551	200	800ma at 135° stud	15A	150°	175°
1N552	300	800ma at 135° stud	15A	150°	175°
1N553	400	800ma at 135° stud	15A	150°	175°
1N554	500	600ma at 135° stud	15A	150°	175°
1N555	600	600ma at 135° stud	15A	150°	175°
1N560	800	250ma at 100° amb.	15A	150°	175°
1N561	1000	250ma at 100° amb.	15A	150°	175°
1N562	800	400ma at 100° stud	15A	150°	175°
1N563	1000	400ma at 100° stud	15A	150°	175°
1N599	50	400ma at 100° amb.	10A	150°	175°
1N599A	50	400ma at 100° amb.	10A	150°	175°
1N600	100	400ma at 100° amb.	10A	150°	175°
1N600A	100	400ma at 100° amb.	10A	150°	175°
1N601	150	400ma at 100° amb.	10A	150°	175°
1N601A	150	400ma at 100° amb.	10A	150°	175°
1N602	200	400ma at 100° amb.	10A	150°	175°
1N602A	200	400ma at 100° amb.	10A	150°	175°
1N603	300	400ma at 100° amb.	10A	150°	175°
1N603A	300	400ma at 100° amb.	10A	150°	175°
1N604	400	400ma at 100° amb.	10A	150°	175°
1N604A	400	400ma at 100° amb.	10A	150°	175°
1N605	500	400ma at 100° amb.	10A	150°	175°
1N605A	500	400ma at 100° amb.	10A	150°	175°
1N606	600	400ma at 100° amb.	10A	150°	175°
1N606A	600	400ma at 100° amb.	10A	150°	175°
1N607	50	800ma at 135° stud	15A	150°	170°
1N607A	50	800ma at 135° stud	15A	150°	170°
1N608	100	800ma at 135° stud	15A	150°	170°
1N608A	100	800ma at 135° stud	15A	150°	170°
1N609	150	800ma at 135° stud	15A	150°	170°
1N609A	150	800ma at 135° stud	14A	150°	170°
1N610	200	800ma at 135° stud	15A	150°	170°
1N610A	200	800ma at 135° stud	15A	150°	170°
1N611	300	800ma at 135° stud	15A	150°	170°
1N611A	300	800ma at 135° stud	15A	150°	170°
1N612	400	800ma at 135° stud	15A	150°	170°
1N612A	400	800ma at 135° stud	15A	150°	170°
1N613	500	600ma at 135° stud	15A	150°	170°
1N613A	500	600ma at 135° stud	15A	150°	170°
1N614	600	600ma at 135° stud	15A	150°	170°
1N614A	600	600ma at 135° stud	15A	150°	170°
1N1095	500	425ma at 100° amb.	15A	150°	175°
1N1096	600	350ma at 100° amb.	15A	150°	175°
1N1100	100	500ma at 100° amb.	15A	165°	175°
1N1101	200	500ma at 100° amb.	15A	165°	175°
1N1102	300	500ma at 100° amb.	15A	165°	175°
1N1103	400	500ma at 100° amb.	15A	165°	175°
1N1115	100	1.5A at 85° stud	15A	170°	175°
1N1116	200	1.5A at 85° stud	15A	170°	175°
1N1117	300	1.5A at 85° stud	15A	170°	175°
1N1118	400	1.5A at 85° stud	15A	170°	175°
1N1119	500	1.5A at 85° stud	15A	170°	175°
1N1120	600	1.5A at 85° stud	15A	170°	175°
1N1487	100	250ma at 125° amb.	15A	140°	175°
1N1488	200	250ma at 125° amb.	15A	140°	175°
1N1489	300	250ma at 125° amb.	15A	140°	175°
1N1490	400	250ma at 125° amb.	15A	140°	175°
1N1491	500	250ma at 110° amb.	15A	125°	175°
1N1492	600	250ma at 95° amb.	15A	120°	175°
1N1692	100	600ma at 100° amb.	20A	115°	125°
1N1693	200	600ma at 100° amb.	20A	115°	125°
1N1694	300	600ma at 100° amb.	20A	115°	125°
1N1695	400	600ma at 100° amb.	20A	115°	125°
1N2154	50	25A at 145° stud	300A	200°	200°
1N2155	100	25A at 145° stud	300A	200°	200°
1N2156	200	25A at 145° stud	300A	200°	200°
1N2157	300	25A at 145° stud	300A	200°	200°
1N2158	400	25A at 145° stud	300A	200°	200°
1N2159	500	25A at 145° stud	300A	200°	200°
1N2160	600	25A at 145° stud	300A	200°	200°
4JA60A*	100	70A at 120° stud	900A	200°	200°
4JA60B*	200	70A at 120° stud	900A	200°	200°
4JA60C*	300	70A at 120° stud	900A	200°	200°
4JA60D*	400	70A at 120° stud	900A	200°	200°
4JA60F*	50	70A at 120° stud	900A	200°	200°
4JA60G*	150	70A at 120° stud	900A	200°	200°
4JA60H*	250	70A at 120° stud	900A	200°	200°
4JA60J*	350	70A at 120° stud	900A	200°	200°
4JA62A*	100	40A at 120° stud	900A	150°	200°
4JA62B*	200	40A at 120° stud	900A	150°	200°
4JA62C*	300	40A at 120° stud	900A	150°	200°
4JA62D*	400	40A at 120° stud	900A	150°	200°
4JA62F*	50	40A at 120° stud	900A	150°	200°
4JA62G*	150	40A at 120° stud	900A	150°	200°
4JA62H*	250	40A at 120° stud	900A	150°	200°
4JA62J*	350	40A at 120° stud	900A	150°	200°

*Also available with reversed polarity.

RECTIFIER STACKS

G-E Type	PIV (up to)	Max. I_{DC} at T°C (up to)
4JA211	630 V	6 amps. at 55° amb.
4JA411	3360 V	18 amps. at 25° amb.
4JA3011	630 V	48 amps. at 55° amb.
4JA3611	1800 V	65 amps. at 55° amb.
4JA6011	840 V	573 amps. at 35° amb.
4JA6211	840 V	430 amps. at 35° amb.



SILICON LOW CURRENT

Series: 1N536-540, 1N547, 1N560-561, 1N1095-1096, 1N440(B)-445(B), 1N1100-1103, 1N1487-1492, 1N599(A)-606(A), 1N1692-1695.

Series: 1N536-540, 1N547, 1N1095-96—Provide maximum forward conductance at high operating temperatures (165° C.). **1N440-445, 1N440B-445B**—Similar to 1N536-540 series, but with extremely low reverse current. Ideal for magnetic-amplifier applications. **1N1100-1103**—Similar to 1N440B-445B series. **1N1487-1492**—Essentially the same as 1N536-540 series, except provides lower-cost units for lower-temperature requirements (140° C.). **1N599-606, 1N599A-606A**—Similar to 1N536-540 and 1N440B-445B series, respectively, except for somewhat lower forward-current ratings. **1N1692-1695**—Provides lower current and temperature operation (115° C.) than any of above series—very economical.

Series: 1N1115-1120, 1N253-256, 1N550-555, 1N332-349, 1N607(A)-614(A), 1N562-563

Series: 1N1115-1120—Available for stud mounting direct to chassis, or finned. Similar, in characteristics, to 1N536-540 lead-mounted series. Provide maximum forward conductance at high operating temperatures. **1N253-256**—High power-handling ability. Primarily for power supply and magnetic-amplifier applications. Type 1N256 meets JAN spec. **1N550-555**—Similar to 1N440B series, except for stud mounting. Extremely low reverse current, particularly suited for magnetic-amplifier applications. **1N332-349**—Industry-popular series. For applications requiring high reliability at moderate currents operating up to 170° C.. **1N607-614, 1N607A-614A**—Another widely-used industrial line. Ideal for applications requiring high currents at up to 150° C.

4JA411 Series

4JA411 Stacks: Combine high temperature operation (up to 150° C.) with increased ratings (up to 18 amps d-c). Hundreds of stack combinations to meet a variety of circuit conditions. High efficiency plus excellent regulation.

POTTED RECTIFIER CIRCUITS

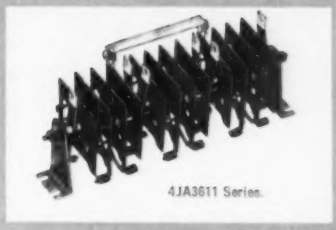
Series: 4JA221 (germanium) 4JA421 (silicon)

4JA220-221, 4JA420-421 Series: Mounted in standard eight-pin tube base (4JA220-420 Series) or in rectangular design with solder lug connections (4JA221-421 Series). Available in a large number of circuit configurations. One to 20 cells may be potted in a single circuit. Individual cell specifications determine ratings. 4JA220-221 Series utilize germanium 1N91-93 cells. 4JA420-421 Series utilize silicon 1N536-540, 1N1095-1096 and 1N1487-1492 cells. (See BASIC RECTIFIER-CELL LISTING at left.)

SILICON MEDIUM CURRENT

Series: 1N2154-2160

1N2154-2160 Series: First series of silicon medium current rectifiers to be made free from thermal fatigue. Designed for individual cell applications in the 2-to-25 amp range. High junction-temperature ratings. Extremely low forward voltage drop and thermal impedance. May be mounted directly, or electrically insulated from heat sink with mica-washer mounting kit provided with each unit.

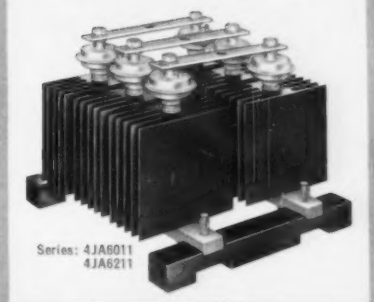


4JA3611 Series

4JA3611 Stacks: Provide a wide-range of power applications with d-c outputs up to 65 amps.

SILICON HIGH CURRENT

Series: 4JA60, 4JA61, 4JA62, 4JA63



Series: 4JA6011 4JA6211

4JA60, 4JA61, 4JA62, 4JA63 Series: Large-area junction stud-mounted rectifiers. Operating temperatures to 200° C. D-c outputs as high as 85 amps per rectifying element. Lower-cost 4JA62, 4JA63 units are for applications which do not require the full-current ratings of 4JA60 line. Reverse polarities provided in 4JA61 and 4JA63 units. **4JA6011, 4JA6211 Stacks:** Hundreds of combinations available in various circuit configurations. D-c outputs up to 375 amps. The 4JA6211 series for lower-current, lower-cost operation.

SILICON CONTROLLED RECTIFIER

Series: C35 ZJ39L

CONTROLLED RECTIFIER RATING CHART

G-E Type No.	PIV* and V_{BO}	Max. I_{DC} at Temp. °C.	Max. Temp. °C. Oper.	Max. Temp. °C. Storage	Max. Req'd Gate Signal
C35U	25	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.
C35F	50	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.
C35A	100	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.
C35G	150	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.
C35B	200	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.
C35H	250	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.
C35C	300	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.
C35D	400	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.

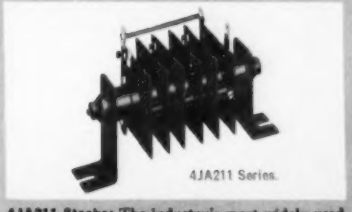
*Max. PIV and Min. V_{BO}.

C35 Series: Revolutionary silicon control device introduced by General Electric. Can do jobs of thyratrons, ignitrons, magnetic amplifiers, power transistors, relays, switches, contactors, circuit breakers, in many power-control and power-switching applications. **Medium-current C35 series** provides blocking voltages to 400V and load currents to 16 amperes. **Low-temperature,** lower-cost **ZJ39L series** also available. Provides blocking voltages to 400V and load currents to 10 amperes. **High-current,** developmental-type **ZJ50 series** is now available on a prototype-sample basis.

GERMANIUM LOW CURRENT

Series: 1N91-93 (USN), 1N151-153, 1N158, 1N315 (USAF), 1N368

Series 1N91-93, USN1N93—Alloyed-junction types combining very low forward resistance with high back resistance to give almost 100% efficiency. 1N93 is commercial version of U.S. Navy MIL-spec. rectifier—the G-E USN1N93. **1N151-153, 1N158**—Single- and two-fin versions of 1N91-93 series cells. **1N315, USAF1N315**—Designed for high operating temp. (to 85° C.) and low reverse current. USAF1N315 meets A.F. spec. MIL-E-1/1068. **1N368**—Features a very low reverse current at a high d-c reverse voltage. For magnetic-amplifier applications.



4JA211 Series.

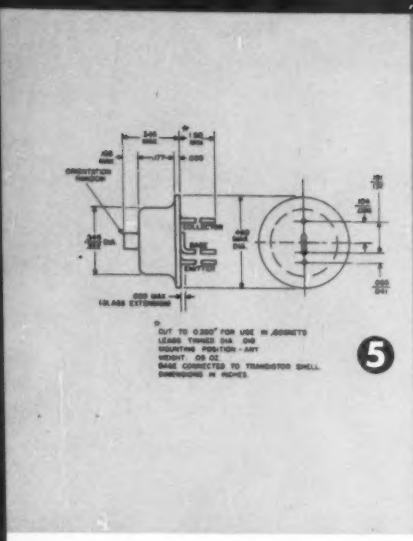
4JA211 Stacks: The industry's most widely-used semiconductor rectifier series. Hundreds of thousands in use. May be arranged in stacks up to 12 fins to produce more than 160 various circuit configurations. Small, lightweight, excellent regulation.

GERMANIUM MEDIUM CURRENT

Single-fin Mounting

4JA3011 Series

4JA3011 Series: For general-purpose power supplies, control devices, blocking circuits, and many other applications. Extremely low power dissipation and forward voltage drop provide excellent regulation and efficiency. Available in stacks up to 12 fins, providing ratings in thousands of watts, depending upon the circuit design, with operation to 85° C. Also, available in single-fin mounting. Transient PIV's up to 600 volts per cell.



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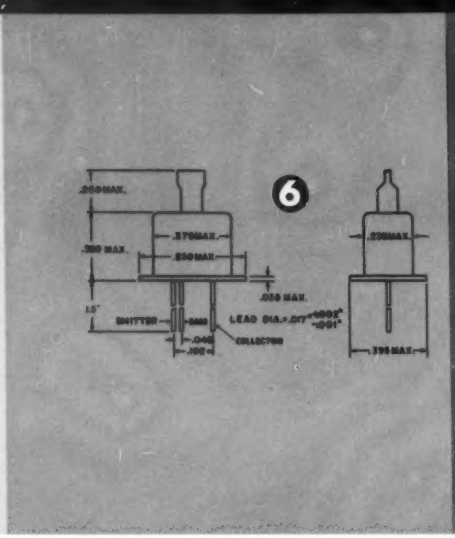

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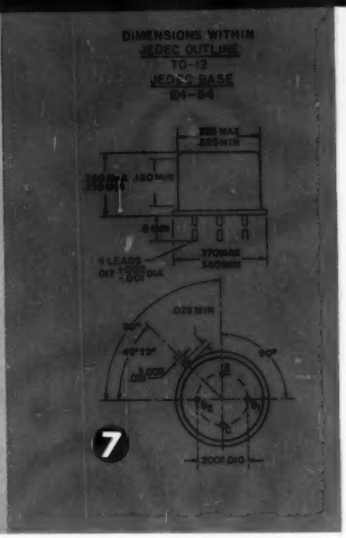

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RATINGS				TYPICAL VALUES						
MAXIMUM COLLECTOR DISSIPATION @ 25° C (mw) P_C	MINIMUM BREAKDOWN VOLTAGE (volts) BV_{CBO}	MAXIMUM COLLECTOR CURRENT (ma) I_C	MAXIMUM STORAGE TEMP. (°C) T_{STG}	D-C CURRENT GAIN h_{FE} (A-C h_{fe})*	ALPHA CUTOFF FREQ. (mc) f_{ab}	POWER GAIN (db) G_e (1000 Cyc.)	SATURATION VOLTAGE (volts) V_{CE} (SAT) R_{SC} (ohms)*	COLLECTOR CAPACITY ($\mu\mu$f) C_{ob}	COLLECTOR TO BASE CURRENT (μa) MAX I_{CO} @	V_{CB}
150	45	25	200	12*	10	35	90*	7	2	30
150	45	25	200	18*	12	39	80*	7	2	30
150	45	25	200	39*	13	40	75*	7	2	30
150	45	25	200	20*	14	42	70*	7	2	30
150	45	25	200	120*	15	43	70*	7	2	30
125	45	20	200	35	30		75*	1.2	1	20
125	45	20	200	75	45		75*	1.2	1	20
P_{AV}	V_{BB} (MAX)	I_E		η	f_{MAX}	R_{BBO}	V_E (SAT)	I_{B2} (MOD)	I_{EO}	@ V_{EB}
450	65	70	175	.56	0.9	5.6	3.1	12	12	60
450	75	70	175	.56	0.7	7.5	3.3	12	12	60
450	65	70	175	.62	0.8	5.6	3.4	12	12	60
450	75	70	175	.62	0.7	7.5	3.6	12	12	60
450	65	70	175	.68	0.7	5.6	3.8	12	12	60
450	75	70	175	.68	0.65	7.5	3.9	12	12	60
P_C	BV_{CE}	I_C		h_{FE}	f_{ab}	G_e	V_{CE} (SAT)	C_{ob}	I_{CO}	@ V_{CB}
240	−30	−300	100	53	1.3		0.09	40	−16	−45
240	−30	−300	100	31	1.0		0.09	40	−16	−45
225	−30	−500	100	35	2.0		0.07	25	−10	−30
225	−30	−500	100	52	2.5		0.075	25	−10	−30
225	−30	−500	100	73	3.0		0.08	25	−10	−30
225	−30	−500	100	91	3.3		0.09	25	−10	−30
150	−15	−125	85	65	8.0		0.15	15	− 6	−20
150	−15	−200	100	20 min	4.5		0.1	12	− 6	−15
150	−20	−200	100	30 min	8.0		0.08	12	− 6	−20
150	−15	−200	100	40 min	12.0		0.07	12	− 6	−15
120	−24	−100	85		8.0		0.1	12	− 5	−12
150	−12	−125	85	30 min	5 min		0.2 max	12	− 6	−12
150	−12	−125	85	60 min	10 min		0.15 max	12	− 6	−12
240	−50	−100	100	32	1.0		0.09	40	−18	−75
240	−30	−300	100	58	1.3		0.08		−16	−45
65	15	20	85	70	9.0			3	3	15
65	25	20	85	72	9.0	26		2.4	5	15
75	30	75	85	30	9.0			2.5	1.5	15
150	20	300	85	15 min	8.0				5	5
150	20	300	85	25 min	12.0				5	5
150	15	300	85	35 min	17.0				5	5
30	6	20	85	2.2∠− 81°	50 min	11.5		2	10	7
30	6	20	85	1.1∠−100°	90 min	9		1.5	10	7

E.

RECTIFIERS Selenium

Copper Oxide • Miniature-Intermediate-Large Stacks

Vac-u-Sel* • High Efficiency Low Voltage

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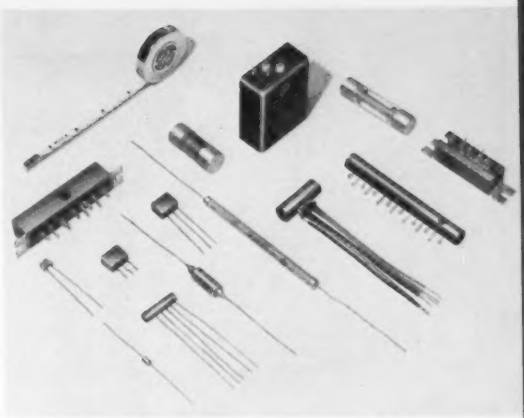


TYPICAL MINIATURE Vac-u-Sel RECTIFIERS

General Electric Company's *Vac-u-Sel* rectifiers are produced through the unique *spherical vacuum-evaporation process*—the quality-advancement pioneered in this country by G.E. Briefly, the vacuum-evaporation process makes it possible to closely control the thickness of the selenium layers to satisfy varying requirements, and to obtain a pure, more even deposition of selenium over the entire cell surface.

VOLTAGES AND CELL SIZES

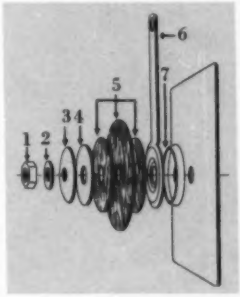
G-E Vac-u-Sel rectifiers are available in cells of 26, 36 and 45 volts (rms), and in cell sizes up to two inches square. Larger sized cells are available in the 26- and 36-volt ranges. Eighteen-volt cells are available as off-standard units in all cell sizes.

FINISHES AND MOUNTINGS

Vac-u-Sel rectifier stacks are supplied with 3 basic finishes: *standard commercial, heavy duty,* and *military.* Selected cells are stud mounted, eyelet and tube mounted, oil immersed or embedded.

MINIATURE CELLS

Miniatures (cells up to $1\frac{15}{32}$" diameter) have no center mounting hole and are mounted without spacer washers, assuring compact assemblies.



FEWER PARTS—improved G-E Cup-Washer Assembly consists of (1) Nut, (2) Metal Washer, (3) Spring Washer, (4) Pressure Washer, (5) Insulating Washers, (6) Terminal, (7) Cup Washer.

COPPER OXIDE RECTIFIERS

General Electric copper-oxide rectifier stacks operate as efficient, economical devices for converting a-c to d-c. They are particularly ideal for such applications as:

- Blocking
- Magnetizing
- Electrolytic reduction
- Polarizing relays
- Metering
- Circuit breakers
- High-speed relays
- Electroplating
- Telephone and telegraph equipment

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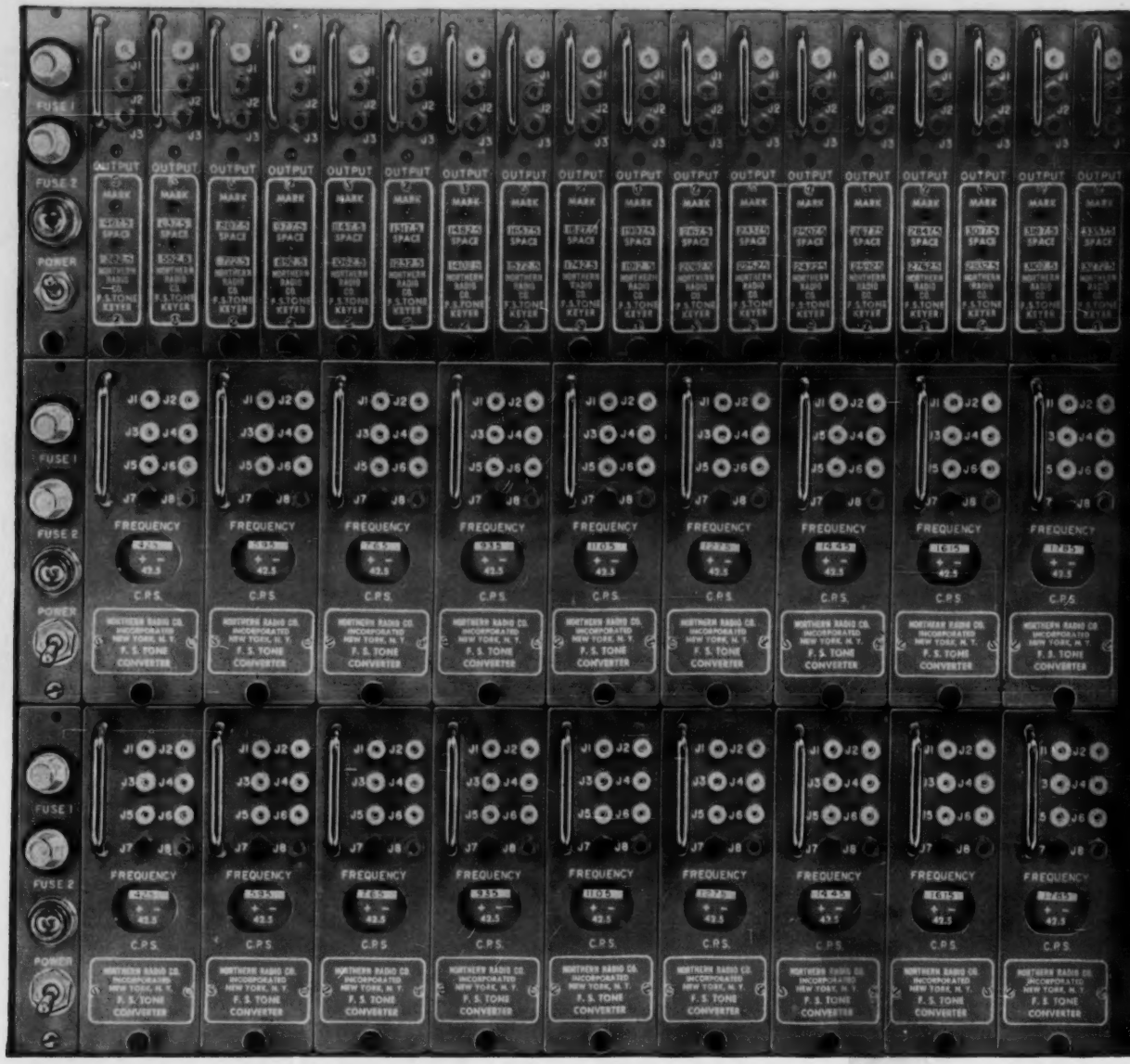

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What's in the IRE Program

Missile electronics, new components and production techniques will command attention at technical sessions coming up this month

ELECTRONICS in outer space will hold the spotlight at the 34th Annual National Convention of the Institute of Radio Engineers. The convention opens a week from Monday, on March 23, in New York's Coliseum and Waldorf-Astoria Hotel.

Key figures in the free world's space exploration program will gather for a seminar Tuesday evening at the Waldorf. In addition, many of the 54 technical sessions will feature papers on missile guidance, airborne electronics, rocket and satellite instrumentation and communications. In all, 248 papers will be presented on subjects ranging from audio to millimeter curves. Categories include:

AIRCRAFT AND MISSILES—Present-day electromagnetic navigation systems are limited by feasible antenna beam widths and base-line lengths attainable on the earth. Use of earth satellites containing navigation equipment has been proposed to overcome these limitations of present-day systems.[1]

A combined beacon to aid missile tracking, coded-reply transmitter to identify the missile, missile command receiver and telemetry unit that occupies only 300 cu. in. will be described.[2]

A continuous-loop magnetic tape recorder is used to store data collected as a missile reenters the earth's atmosphere. Ionization of atmospheric gas due to high missile-reentry temperatures causes a radio communication blackout during reentry. The tape-recorded data can be transmitted after the missile nose-cone emerges from the ionization region.[3]

A low-cost dependable missile miss-distance indicator is no longer than a vest-pocket radio receiver.

The indicator accurately and instantaneously scores miss distances up to 200 ft.[4]

MATERIALS AND COMPONENTS—Results of experiments with variable-capacitance parametric amplifiers and converters in the 500 to 3,000 mc band show that noise figures under one db can be obtained with a regenerative converter. A balanced system uses a hybrid and two regenerative converters to minimize effects of load variations.[5]

A new backward-wave oscillator is electronically tunable over a 60 to 75 kmc range. Average power output is 4 milliwatts—nowhere less than 1 milliwatt. Twelve tubes of this kind have been constructed.[6]

A practical use of the Hall effect occurs when an indium antimonide device is inserted between two ferrite pole pieces. The device is used to measure low-frequency magnetic-field interference.[7]

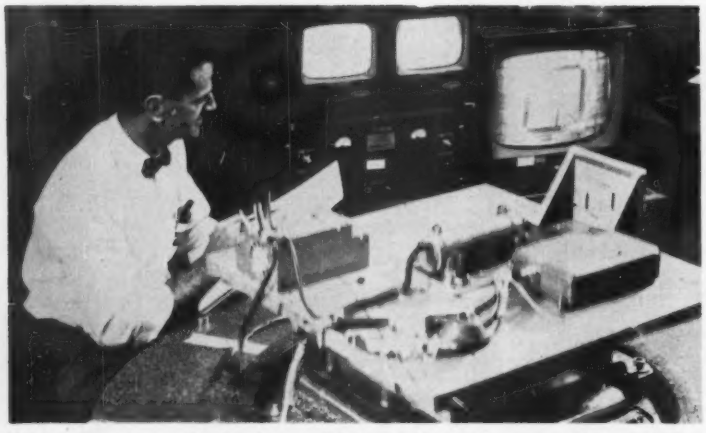
PRODUCTION TECHNIQUES—A major development in the electronics industry will be use of thin films deposited on some supporting structure to build up complete circuits. In one system the operation of the circuit is monitored as the films are deposited. The deposition is cut off when desired characteristics are achieved.[8] One important development has been use of evaporated nickel-iron films to make logic and memory circuits for digital computers.[9]

STEREOPHONIC SOUND—A forward step in stereo reproduction may result as three sound channels are derived from two sound tracks on magnetic tape.[10]

An amplifier circuit will be shown in which one pair of output tubes handles both right- and left-hand channels of a stereo program. Key to operation is a special matrixing output transformer.[11]

INDUSTRIAL ELECTRONICS—Use of automobile-mounted radar to follow a foil strip in the middle of the road may be the key to safe hands-off driving. The set will use

Tiny Tv System for Space Flights



Although sustaining vibration forces of being rocketed into space, miniature battery-powered tv system transmits test pattern to monitor (upper right). Designed by Lockheed Missiles and Space division, system has 1,000-mi transmitting range, weighs only 9 lb

a klystron not only as transmitter but also as modulator, r-f amplifier and video detector.[12]

Basic data will be presented on ultrasonic welding. The technique is analyzed as being a form of pressure or friction welding.[13]

Equivalent designers will want to hear how a typical uhf communications receiver was redesigned entirely on the throw-away module principle.[14]

Also to be described is a pocket-carried battery-powered system that internally paces and monitors the heart.[15]

COMPUTER SIMULATION — A large digital data-processing machine has been programmed to simulate perceptual learning. This computer is set up to respond to inputs that it seeks.[16]

Another mathematical model represents the air-traffic problem around New York City in 1960. Model will be used to devise electronic equipment capable of handling the expected air volume.[17]

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(16) Frank Rosenblatt, Perceptron Simulation Experiments, IRE Conv. paper No. 17.5

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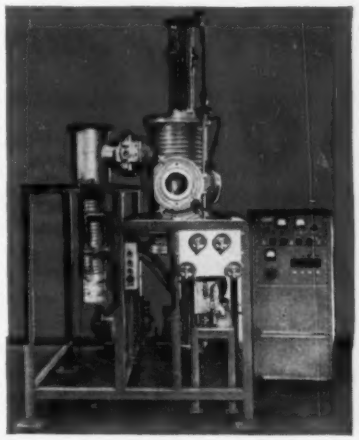

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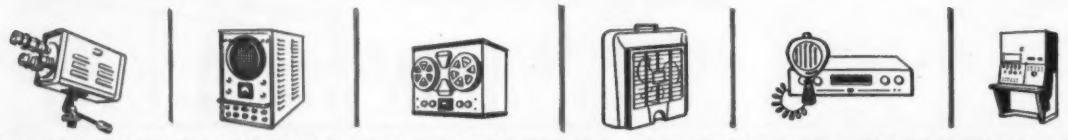
Unlike conventional or phonograph-motor-assemblies, the MUFFIN® FAN boasts a high air performance of 100 CFM free delivery from a basic package only 4-11/16" square and only 1-1/2" deep while the weight is but 1-1/2 pounds. The completely original aerodynamic design permits operation through a dust filter and tightly packed electronic equipment.

Unbelievably thin . . . entire fan assembly is only 1-1/2" thick! Protrusion into cabinet is 1-1/2" MINUS the panel thickness. The MUFFIN® FAN will mount into wall of cabinet imposing practically no space requirement inside the enclosure.

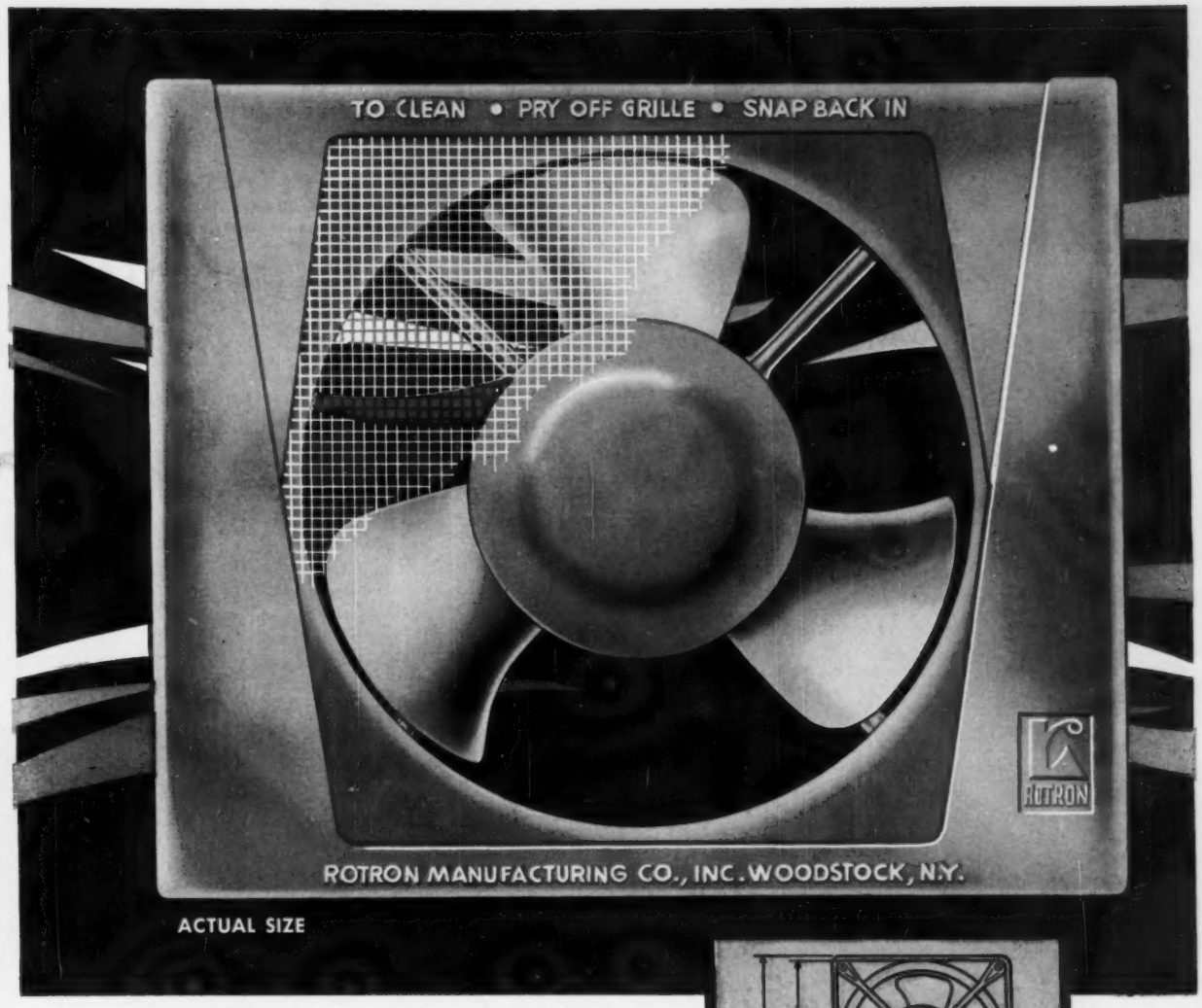
The MUFFIN® FAN is a completely integrated cooling unit. The propellor and stator assemblies, venturi block, grille assembly and ingenious all-purpose mounting clips combine to form a *complete* package. The MUFFIN® FAN can be installed in a rectangular cutout in a panel in just seconds. When installed it represents the ultimate in cooling efficiency and a distinct asset to equipment appearance.

In addition, the MUFFIN® FAN provides the following distinct features . . . extremely quiet operation . . . will fit any panel thickness from 1/32" up . . . no capacitor, commutator or slip-ring . . . exclusive no-maintenance motor . . . flow direction quickly and easily changed by turning fan end-for-end . . . all electrical parts including terminal lugs are molded into water-tight shell.

The high performance level of the MUFFIN® FAN together



JUST A FEW OF THE MANY APPLICATIONS FOR THE ROTRON MUFFIN® FAN



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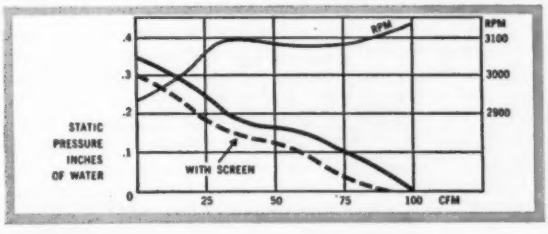
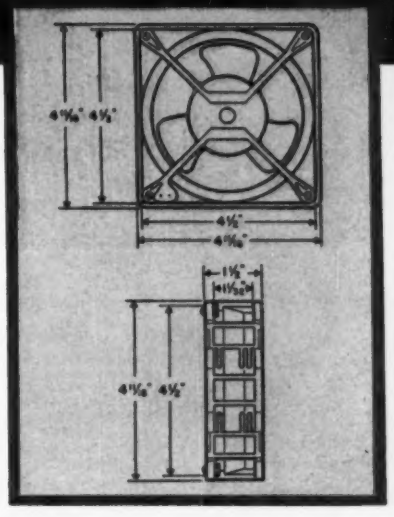
with its extremely compact size and economical cost provides for the first time efficient forced-air cooling in equipments where space or cost limitations previously made cooling prohibitive.





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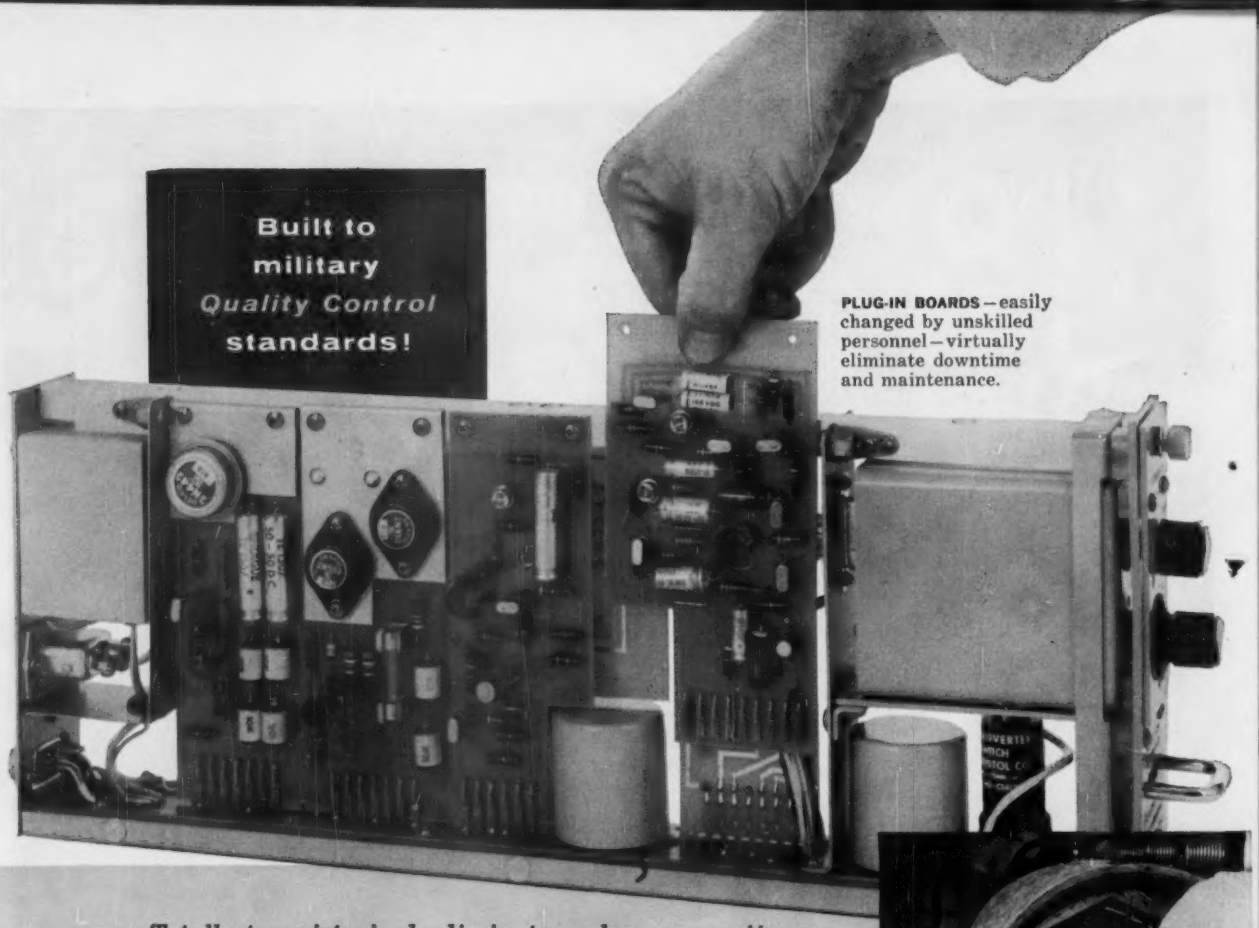
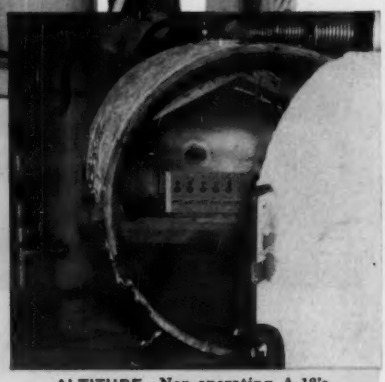


PLUG-IN BOARDS—easily changed by unskilled personnel—virtually eliminate downtime and maintenance.

Totally transistorized—dissipates only seven watts.
Drift less than 2 microvolts per 200 hours.
Single ended or differential input.
19" panel accommodates eight instruments.
DC to 50,000 cps.
Noise less than 10 microvolts wideband.
Operates to specifications from 0 to 50°C.
Self-contained power supply—operates on any line frequency from 50-400 cps.
Mil-type chopper gives unmatched reliability for the life of the instrument.



ALTITUDE—Non-operating A-12's were subjected to 1.6 psi (50,000') for one hour, and then operated at 6,000' and at sea level pressures.

SPECIFICATION SUMMARY – MODEL A-12

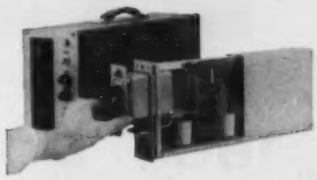
	Single Ended Input	Differential Input
Gain:	Fixed gain set to any value from 10 to 1000 inclusive by front panel plug-in units. Gain switching plug-in attenuator available with gains of 0, 10, 20, 50, 100, 200, 500 and 1000. Adjustable upward 2½ to 1 or more from setting with potentiometer.	Fixed gain set to any value from 10 to 1000 inclusive by front panel plug-in units. Gain switching plug-in attenuator available with gains of 0, 10, 20, 50, 100, 200, 500 and 1000. Adjustable upward 2½ to 1 or more from setting with potentiometer.
Input Impedance:	100 megohms shunted by 0.001 mfd (typical).	10,000 ohms.
Source Impedance:	5K maximum.	
Drift:	Less than 2 microvolts in 200 hours at constant ambient temperature. Less than 0.4 microvolt per degree centigrade.	Less than 4 microvolts in 200 hours at constant ambient temperature. Less than 0.8 microvolt per degree centigrade.
Ambient Temperature:	0° to 50°C.	0° to 50°C.
Noise (Referred to input):	0-3 cps 5 microvolts peak to peak. 0-750 cps 5 microvolts rms. 0-50 kc 10 microvolts rms.	0-3 cps 10 microvolts peak to peak. 0-750 cps 7 microvolts rms. 0-50 kc 14 microvolts rms.
Frequency Response:	±3db to 50 kc (typical); ±1.0% to 2 kc.	±3db to 50 kc (typical); ±1.0% to 2 kc.
Output Capability:	±10 volts at ±100 ma DC or peak AC to 10 kc.	±10 volts at ±100 ma DC or peak AC to 10 kc.
Common Mode Rejection:		100db at DC; 72db at 60 cps for common mode voltage up to 50 volts DC or peak AC.

CIRCLE 40 READERS SERVICE CARD

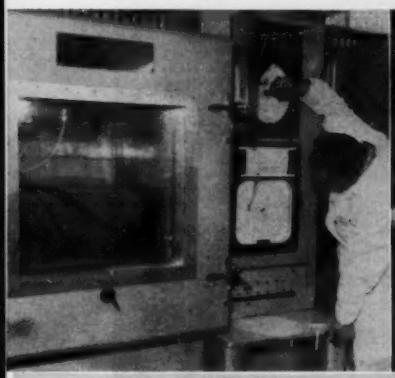
Only Electro Instruments DC Amplifiers meet rugged military environmental tests!

Totally-transistorized Model A-12's picked for ICBM Ground Support Equipment

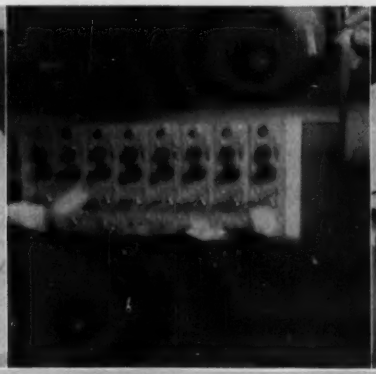
The photographs below were taken while eight Model A-12's were undergoing environmental qualification tests by independent MIL-approved laboratories.



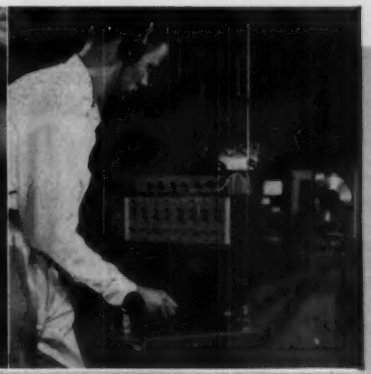
PLUG-IN ATTENUATORS provide a choice of differential, single ended, or operational inputs for maximum operator convenience, flexibility and economy. Special variations, gain settings, etc., can be tailored to *your* system at no extra cost.



TEMPERATURE—The A-12's were operated at 50°C. ±2° for 12 hours and at 0°C. for 12 hours, and after storage at 70°C. and −40°C. for 24 hours.



SHOCK—The A-12's were subjected to 4" pivot drops and 1" free drops on all practicable faces for a total of five drops on each face.

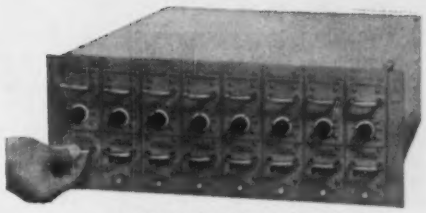


ELECTRO INTERFERENCE—All tests conformed to RADC Exhibit 2313A.

The A-12 is certified as incorporating no fungus nutrient material!

Design and construction techniques of the Model A-12 Amplifier are fully *two years ahead of the field!* Totally transistorized circuits give the A-12 unmatched reliability and performance, and minimize heat dissipation problems inherent in vacuum tube instruments. Plug-in etched circuit boards and modular internal construction make servicing and maintenance checks easy—the amplifier can be disassembled and reassembled in less than 10 minutes. These advanced features enabled the Model A-12 to meet stiff military environmental qualification tests and resulted in their being selected for use in the ground support equipment of the nation's most advanced ICBM program.

Why not ask your E-I representative for the full story today?



SMALLEST PACKAGE EVER!
Eight Model A-12's can be mounted in standard 19" panel.

Electro Instruments, Inc.

3540 AERO COURT
SAN DIEGO 11, CALIFORNIA

see us at the
IRE SHOW
booths
2505 *and* 2507

The many advance design features of the Trimpot have proved themselves repeatedly in major aircraft/missile systems and in commercial electronic equipment where reliability, accuracy plus miniature size are of prime importance. Pinpoint settings made on the Trimpot remain stable under the most severe environmental conditions. And — these units save important space — typical size is 1¼"x 5/16"x 3/16". Bourns offers the world's largest selection of leadscrew actuated potentiometers...over 500,000 units in distributors' warehouses across the nation to fill your orders. Before specifying, investigate Bourns Trimpot, the original leadscrew actuated potentiometer. Write for our new Model Summary Brochure #4 and list of stocking distributors.

ONLY BOURNS TRIMPOT® GIVES YOU ALL THESE OUTSTANDING FEATURES

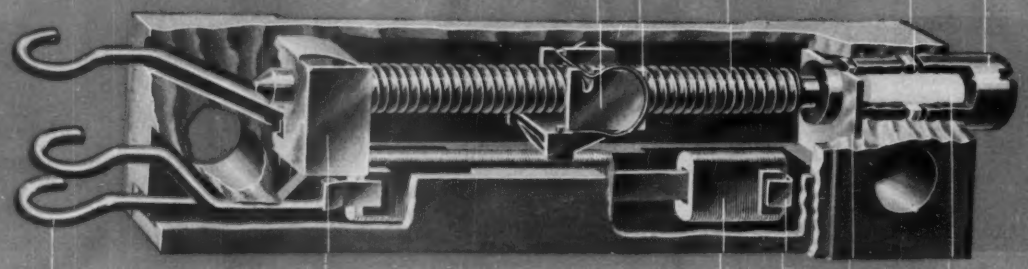
SPRING — Carriage spring provides positive no-slip performance during rotation plus a reliable idling feature at mechanical limits of travel.

LEAD SCREW — Stainless steel lead screw for low noise, high performance during rotation.

O-RING — Silicon rubber O-Ring seals potentiometer against humidity. Prevents flashover to shaft head for high voltage operation.

SHAFT HEAD — Stainless steel with machined slot for screwdriver adjustment. Meets military salt spray requirements.

WIPER CARRIAGE — Gold-plated carriage is welded to precious metal wiper for low noise.



SOLDER TERMINALS — Tinned terminals are compact, yet large enough for easy soldering. Teflon-insulated leads and printed circuit pins are also available.

SILVERWELD* TERMINATION — Exclusive with Bourns potentiometers. Unequalled in ruggedness. A metal-to-metal bond from the terminal to the resistance wire.

PICK-OFF — Gold-plated beryllium copper pick-off maintains constant pressure on lead screw.

ELEMENT — Special ceramic element card for maximum reliability in precision wound with low-temperature-coefficient resistance wire.

SHAFT RETAINER — Shaft is locked in place for top performance under extreme shock, vibration and acceleration.

SHAFT INSULATOR — High-dielectric-strength, ceramic insulator isolates shaft head from internal circuits.

This cutaway of Model 224 is typical of the design of all Bourns potentiometers though some features vary from model to model.

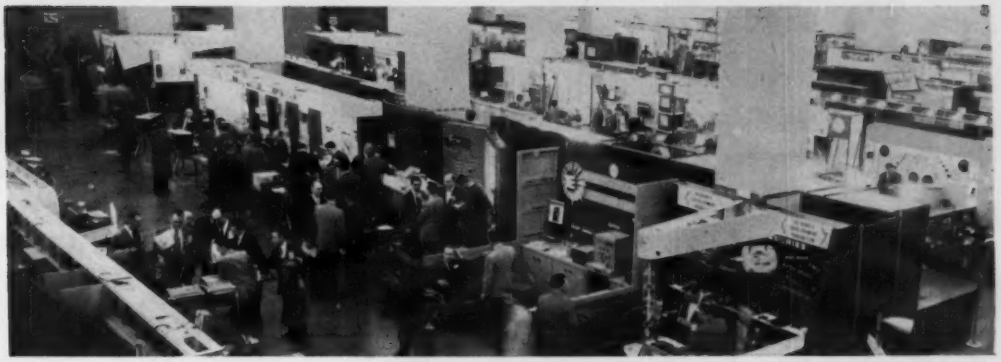
ACTUAL SIZE

Most models available with insulated stranded leads, solder lugs or printed circuit pins in resistances from 10Ω to 1 Meg.

BOURNS
Laboratories, Inc.
P.O. Box 2112A, Riverside, California
Plants: Riverside, Calif. and Ames, Iowa

*TRADEMARK

Exclusive manufacturers of TRIMPOT®, TRIMIT®. Pioneers in potentiometer transducers for position, pressure and acceleration



"One 'brochure collector' later ordered 200 of our highest-priced units . . ."

IRE Exhibitors See Good Year

Electronics men unveiling wares in New York City this month expect new national sales record to top last year's by eight percent

COMMENTS by exhibitors, big and small, at this year's Institute of Radio Engineers national convention point to a record year ahead.

West Coast prime aircraft and missile manufacturers participating in the four-day New York event starting a week from Monday, report firm backlogs amounting to over $4 billion. They say "a good portion" is electronic.

Our industry came out of the '58 slump as one of the few in the nation to establish a new sales record. National total for last year is gaged at $100 million above 1957. Predictions are that this year will top last year's gross by about 8 percent.

Even so, many exhibitors say last year's downturn in military spending hit them hard. A New Jersey exhibitor reports his firm was forced to find industrial users for its product lines. The result is good - - - a whole new area of manufacture and a promising sales field for this year.

A Los Angeles based show-participant substantiates this by saying 5 to 15 percent of his firm's '59 sales will come from new products. Many electronics firms in the Bay Area believe the proportion of non-military business will increase, with commercial sales expanding more rapidly than military buying.

A promising field for this year, according to a western exhibitor who manufactures traffic control systems, is air traffic and industrial process control equipment. This opinion is based on the belief that increased air traffic, especially in jets, will create new markets for traffic control equipment.

One instrument manufacturer says the '58 slump was a good thing for his firm. "Our production people found ways to economize and our sales people learned how to sell when the tide was running against them. The lessons we learned last year are now showing up to great advantage," he says.

This is echoed by a component manufacturer who sees this year as one of "cost cutting, hard selling and hard work." His firm expects increased competition from foreign manufacturers.

Boosts to Business

Some firms at the show are finding a major stimulus in the arrival of passive defense systems, such as BMEWS and Air Com, at the procurement stage. For several New England exhibitors this, along with missile progress, means good news - - - especially for firms manufacturing transistors and associated components.

Other New England booth-holders say significant stimulus for their industrial markets is seen in the computer field's growth.

Without exception, among small manufacturers, participation in the convention is seen as a definite boost to business.

A New York exhibitor manufacturing control equipment calls the annual IRE convention "a valuable source of new ideas." He says "many of this year's products in my company lines are the results of comments collected at last year's exhibit."

"It's a good way to sample opinion," says a manufacturer of oscilloscopes. "One item now moving very nicely was shown for two years in a row in various pilot model forms before we actually went into production."

Highly valued, according to exhibitors, are the person-to-person contacts made possible by the show. One Chicago sales manager puts it this way: "A few minutes' talk with a man who stops at your booth can accomplish more than a dozen letters and phone calls."

Exhibitors smiled when questioned about the seemingly endless numbers of literature collectors who take one of each brochure available and scurry on their way. But a test equipment sales engineer was one of many who feel it's all worth it. He mentioned a "collector" who picked up everything in sight, seemingly without any selectivity. A few months later the "gatherer" walked into the firm's New York plant and ordered 200 of its highest-priced test units.

It takes a TEAM
to solve timing problems

The control of time is an extremely complex science that demands a thorough knowledge of many individual technologies. For this reason, Haydon maintains a team of engineering specialists to provide the reservoir of skill, knowledge, experience, and creative ability necessary to solve industry's timing problems.

When you submit a timing problem to Haydon, it's handled by a team of specialists – *not* an individual engineer. And you can be sure the Haydon Timing Team is equipped with all the electric, electronic, mechanical and manufacturing know-how needed to analyze your requirements and develop the best possible new or modified timing unit for your specific application.

Correctly designed and efficiently manufactured, Haydon timing devices are exhaustively tested before release to a customer. The results are uniformly high quality devices that are known for fine performance, and long life. May we put our Timing Team to work for you?

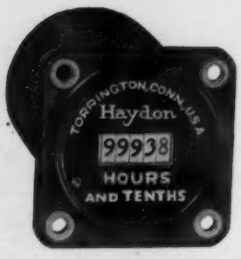
A few units from the complete Haydon line are shown at the right. Send now for further information, outlining your requirements.

Haydon
AT TORRINGTON

DIVISION OF
GENERAL TIME CORPORATION

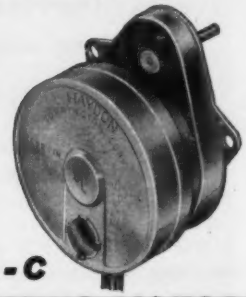
2427 EAST ELM STREET
TORRINGTON, CONNECTICUT

Headquarters for Timing



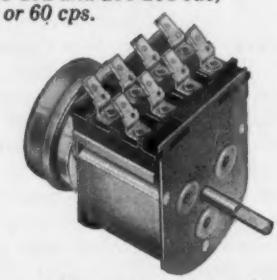
ELAPSED TIME INDICATOR ED-71

Compact, low-cost instrument for machine tools, communications equipment and other commercial applications where an accurate record of operating time is desired. Time Registered: 9,999.9 hours. Weight: 5 oz. Voltages: 120 or 240 v, 60 cps. Power Required: 2.5 watts at 120 v, 60 cps.



A-C TIMING MOTORS

A complete line of synchronous, compact timing motors, speeds from 1/60 to 60 rpm. Guaranteed torques from 6 ounce-inches to 30 ounce-inches at 1 rpm. Voltage ranges 103-132 and 206-264 vac, 50 or 60 cps.



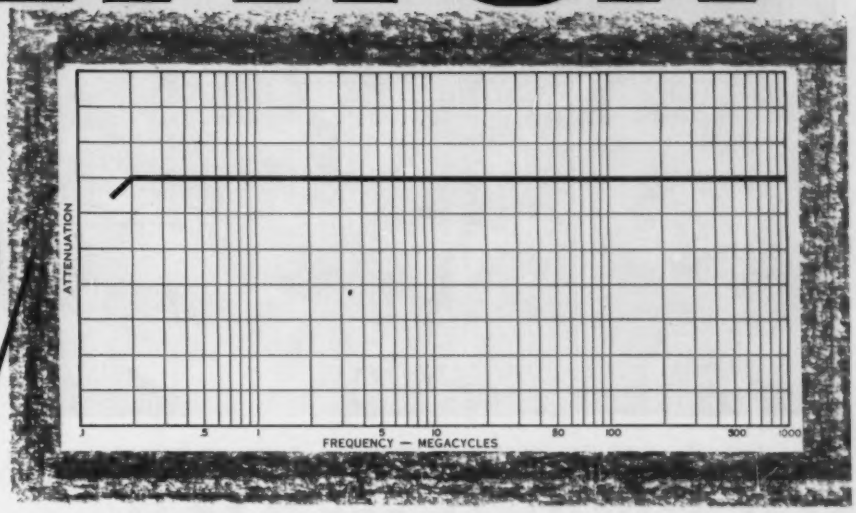
INTERVAL TIMER

Directly controls heavy duty electrical loads. Type AD can be supplied with up to 3 SPST switches. Type AT has 1 SPST switch only. Intervals available with dial and knob: 15, 60 and 180 minutes. Intervals to meet your specific requirements can be supplied. Voltages: 120 or 240 v, 50 and 60 cps. Switch Rating: 28 amps, 250 vac non-inductive; 1 hp, 240 vac.

CIRCLE 43 READERS SERVICE CARD

how to meet/exceed MIL-SPECS..

FILTRON®



RF INTERFERENCE SUPPRESSION

FILTERS

Filtron's prime objective has always been the suppression of radio frequency interference. This objective has been fulfilled thousands of times in making customer's equipment conform to specified performance levels, whether Military, F.C.C. or Industrial.

Filtron first determines what form and magnitude of suppression is necessary to meet specifications. This is accomplished in our modern fully-equipped screen rooms and engineering laboratories, situated in Flushing, N. Y., and Culver City, Calif. Next, each phase of design and production is company controlled, as our capacitor manufacturing division, coil winding division, metal fabrication shop and metal stamping departments are exclusively producing the highest quality components for Filtron's RF Interference Filters.

If you have a RF Interference Filter problem, consult Filtron—the most reliable name in RF Interference Filters.

Send for your copy of our NEW CATALOG.

FILTRON CO., INC. FLUSHING, NEW YORK · CULVER CITY, CALIFORNIA

Visit our Booths 2841-43 at the IRE Show

News from Raytheon's Semiconductor Division...

ELECTROLYTIC SLICING— This engineer is slicing a germanium crystal by electrolytic means. Up to now semiconductor wafers have been formed by mechanical processes, such as cutting with diamond saws or lapping with abrasive powders. The resulting mechanical damage to the critical surfaces reduces the quality and effectiveness of finished semiconductor devices. Electrolytic slicing of crystals, producing surfaces which are free from the mechanical damage resulting from other methods, is one of the many pioneering activities initiated and carried forward by the scientists and engineers of Raytheon's Semiconductor Division.

THE PLACE FOR THE MAN WHO IS GROWING FASTER THAN HIS ASSOCIATES

There are openings at Raytheon's Semiconductor Division for scientists and engineers with semiconductor experience and a desire to find more room for personal and career growth. Opportunities exist in the following areas:

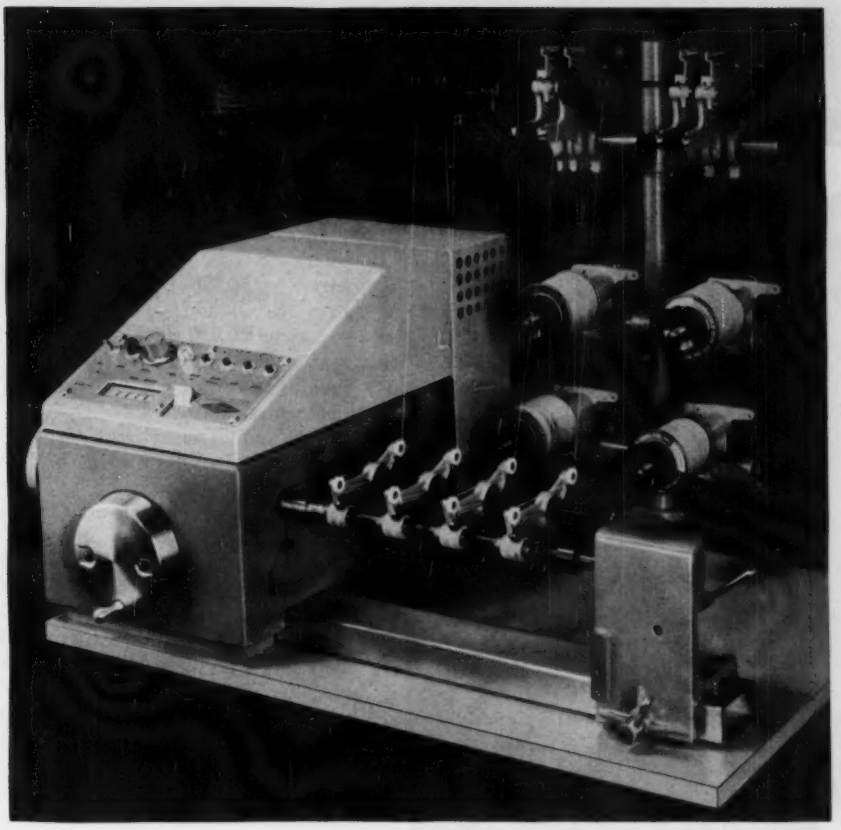
Device Design and Development
Material Development
Mechanization
Circuit Design
Application Engineering

You are invited to explore the advantages for yourself in associating with Raytheon's Semiconductor Division. Write to Mr. Allen E. Moorhead, RAYTHEON MANUFACTURING COMPANY, Semiconductor Division, 150 California Street, Newton 58, Massachusetts.

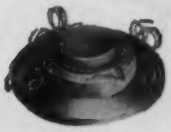
The place for the man who is growing faster...

SEMICONDUCTOR DIVISION of RAYTHEON

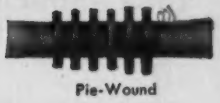
Excellence in Electronics



The No. 111 Cross-Winds These or any other Universal Type Coil

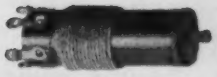


Flyback

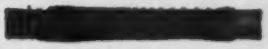


Pie-Wound

Linearity



Constant pitch progressive



Variable pitch progressive

For Widest Versatility in Cross-Wound Coil Production...

The Leesona® No. 111 Coil Winder

Equipped with a progressive coil attachment, the Leesona No. 111 can be used for high speed winding of variable and constant pitch progressive coils. And an optional pie-winding attachment automatically indexes coils from 3/32″ to ½″ between coil centers.

Besides versatility, plenty of other advantages are built into the No. 111 Cross-Winder. The change gears can be dropped into position on fixed centers, without tools, for quick set-up and proper meshing — a Leesona time-saving exclusive.

Also, breakage of fine wire by abrupt starts is eliminated. An electronic drive starts the arbor slowly, gradually accelerates to full pre-set speed and maintains a constant speed rate for uniform wire tension and coil density.

Winding coils singly or in multiple, the No. 111 produces coils up to 3½″ diameter . . . at high speeds . . . accurately and uniformly . . . reduces rejects . . . is simple to set up, run and maintain. Get further facts by sending for the No. 111 Bulletin.

23B.8.7

Universal Winding Company
P. O. Box 1605, Providence 1
Rhode Island, Dept. 123

Please send me:

☐ Bulletin on the Leesona No. 111 Coil Winder

☐ Condensed catalog on Leesona Winders

Name.....*Title*.....

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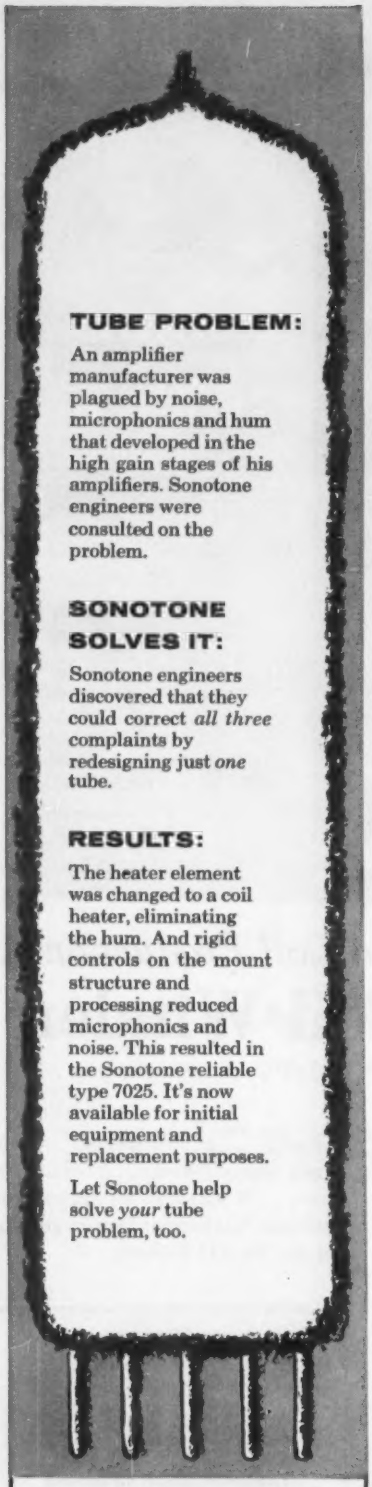
LEESONA

. . . USE LEESONA WINDING MACHINES

See us at booth number 4323 and 4325 at the I.R.E. Show.



TUBE PROBLEM:

An amplifier manufacturer was plagued by noise, microphonics and hum that developed in the high gain stages of his amplifiers. Sonotone engineers were consulted on the problem.

SONOTONE SOLVES IT:

Sonotone engineers discovered that they could correct *all three* complaints by redesigning just *one* tube.

RESULTS:

The heater element was changed to a coil heater, eliminating the hum. And rigid controls on the mount structure and processing reduced microphonics and noise. This resulted in the Sonotone reliable type 7025. It's now available for initial equipment and replacement purposes.

Let Sonotone help solve *your* tube problem, too.

Sonotone.

Electronic Applications Division, Dept. TRR-391

ELMSFORD, NEW YORK

Leading makers of fine ceramic cartridges, speakers, microphones, tape heads, electron tubes.

In Canada, contact Atlas Radio Corp., Ltd., Toronto

CIRCLE 47 READERS SERVICE CARD

Recruiters Roll Up

Demand is strongest for top men for work on advanced weapons. Recruiting during IRE convention starting a week from Monday may be hot

RECRUITING for top-notch electronics engineers in 1959 is likely to be more competitive than last year. Demand is greatest for graduates with a few years' experience in advanced weapons development and space technology.

Two useful indicators of engineer demand are recruiting during this month's annual IRE convention and engineer "help wanted" advertising. Here are the straws in these winds:

• If the early pace of registrations and hotel reservations for the IRE convention (March 23-26) holds up, recruiters may have their busiest convention. Total registration may top 60,000 for a new peak, about 10 percent ahead of last year, the previous record year.

More Inquiries

A corresponding increase is indicated for reservations for recruiting and hospitality suites at New York hotels. Inquiries from companies about recruiting procedures during the convention appear to be much more numerous than in 1958.

• Help wanted display advertising in a New York daily newspaper climbed to a new monthly linage high in January—195,463 lines compared to 58,325 in January 1958. Previous January peak, in 1956, was some 20,000 lines short of this year's mark. About 97 percent of such linage is for engineers, mostly electronics engineers.

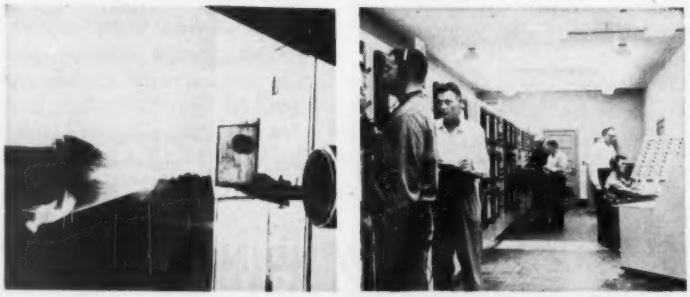
Big jump in advertising for engineers, despite downward projections of '59 demand made last year by many firms, could mean: (1) the projections were overly conservative due to the recession; and/or (2) despite the relative stability of demand for most engineers, the demand for high caliber experienced men for specialized weapons work has skyrocketed to the point where a shortage exists and competition among firms is waxing hotter than ever for them.

The Engineering Manpower Commission of the Engineers Joint Council recently published a survey of 1958 engineer demand, based on data collected last summer. Of interest to electronics engineers are these facts gleaned from the survey:

Gain Despite Recession

While the total number of all engineering graduates surveyed in industry rose an estimated 7,730 to about 153,889 in 1958, some 5,572

Testing Missile Nose Cones



Experimental nose cone model (left) undergoes simulated re-entry test at Army Ballistic Missiles Agency at Huntsville, Ala. Recording of tests is directed from central console (far right), while readouts are made on battery of Leeds & Northrup recorders nearby

Sleeves

went into five categories of industry involved in electronics. The categories include 23 companies in electrical machinery and electronics, and 22 aircraft, 9 instrument, 24 R&D and 7 telecommunications firms. Their graduate engineer census went from 82,361 in 1957 to 87,933 in 1958 despite the recession, apparently because of stepped-up missile and space programs.

This net gain in number of graduate engineers was also achieved despite turnover in the five categories of about 8 percent for electrical-electronics, 13 percent for aircraft, 15 percent for instrument-makers, 5 percent for telecommunications and 10 percent for R & D.

The survey requested estimates of 1959 recruiting goals, but not all of the companies surveyed could give projections of future needs. However, this much is clear:

• In the electrical-electronics category, 21 of the 23 firms participating in the survey last year hired an estimated 1,882 new graduates and 3,050 experienced grads in 1958, said they seek 2,445 new grads and 3,431 experienced ones in '59. Comparable '57 figures were 2,669 and 4,606.

• All 22 of the aircraft firms participating hired 2,852 new and 4,740 experienced grads in '58, seek 1,917 new and 3,006 experienced grads this year. But this downward projection was obtained at a time when contract cancellations and cutbacks were seriously affecting the industry. Since then, new contracts have apparently increased specialized manpower needs, forcing aircraft firms to advertise heavily for electronics engineers.

• In the R&D category, 17 of the 24 participating firms hired 225 new and 198 experienced grads last year, seek 236 new and 348 experienced grads in '59.

• Replies from firms in the telecommunications and instruments categories do not give the full picture, but recruiting activity is likely to be above last year's level.

Tape specs are getting tougher every year

* higher recording densities
(up to 2,000 bits per inch)
* more tracks
(16 channels per inch)
* greater accuracy
(1 error per 40 million)
audiotape
...but not too tough for Audiotape

Keeping *ahead* of its customers is the only way a magnetic tape manufacturer can meet the rapidly rising standards being set for its product. And often the standards are as varied as they are exacting. Special slitting tolerances, coating thicknesses, base materials and magnetic oxides are rapidly becoming more usual than novel. Audio Devices' battery of Automatic Certifiers is one of the unique means used to make sure EP Audiotape always meets customer specifications.

Type EP Audiotape is the *extra precision* magnetic recording tape for applications in computing, automation, telemetering and seismography. The Automatic Certifier records and plays back every inch of the EP Audiotape under test. These tests can be so demanding that if the tape fails to reproduce a single test pulse out of the 40 million put on a single reel, the entire reel is rejected. There are no ifs, ands or buts.

This is one of many special quality-control operations to which EP Audiotape is subjected. From raw materials to hermetically sealed containers, every reel gets individual attention.

EP Audiotape quality is so well verified by instruments like the Automatic Certifier that every reel is guaranteed to be defect-free! For more information write for free Bulletin T112A. Write Dept. TE, Audio Devices, Inc., 444 Madison Avenue, New York 22, N. Y.

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CIRCLE 48 READERS SERVICE CARD

FLEXIBILITY IN THE FIELD...

just one of the many useful features of

EMPIRE'S NOISE & FIELD INTENSITY METER MODEL NF-105

Model NF-105 remotely located from its antenna, for personnel safety.

- Measures 150 kilocycles to 1000 megacycles accurately and quickly with only one meter.
- Approval status: MIL-I-6181B, Class 1, MIL-I-6181C, Category A; MIL-I-26600 (USAF).
- Direct substitution measurements by means of broad-band impulse calibrator, without charts, assure repeatability.
- Self-calibrating, for reliability and speed of operation.
- True peak indication by direct meter reading or aural slideback.
- Four interchangeable plug-in tuning units, for extreme flexibility.
- Economical . . . avoids duplication.
- Safeguards personnel . . . ALL antennas can be remotely located from the instrument without affecting performance.
- Compact, built-in regulated A and B power supply, for stability.
- Minimium of maintenance required, proven by years of field experience.

Only the Model NF-105 is so simple to operate that one technician can take readings over the entire frequency range in less time than required by three engineers manning any other three separate instruments.

Send for our Catalog No. N-357

edp

EMPIRE DEVICES PRODUCTS CORP.

AMSTERDAM, NEW YORK — VICTOR 2-8400

MANUFACTURERS OF:

FIELD INTENSITY METERS • DISTORTION ANALYZERS • IMPULSE GENERATORS • COAXIAL ATTENUATORS • CRYSTAL MIXERS

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CIRCLE 49 READERS SERVICE CARD

CIRCLE 50 READERS SERVICE CARD

there IS

a new way!

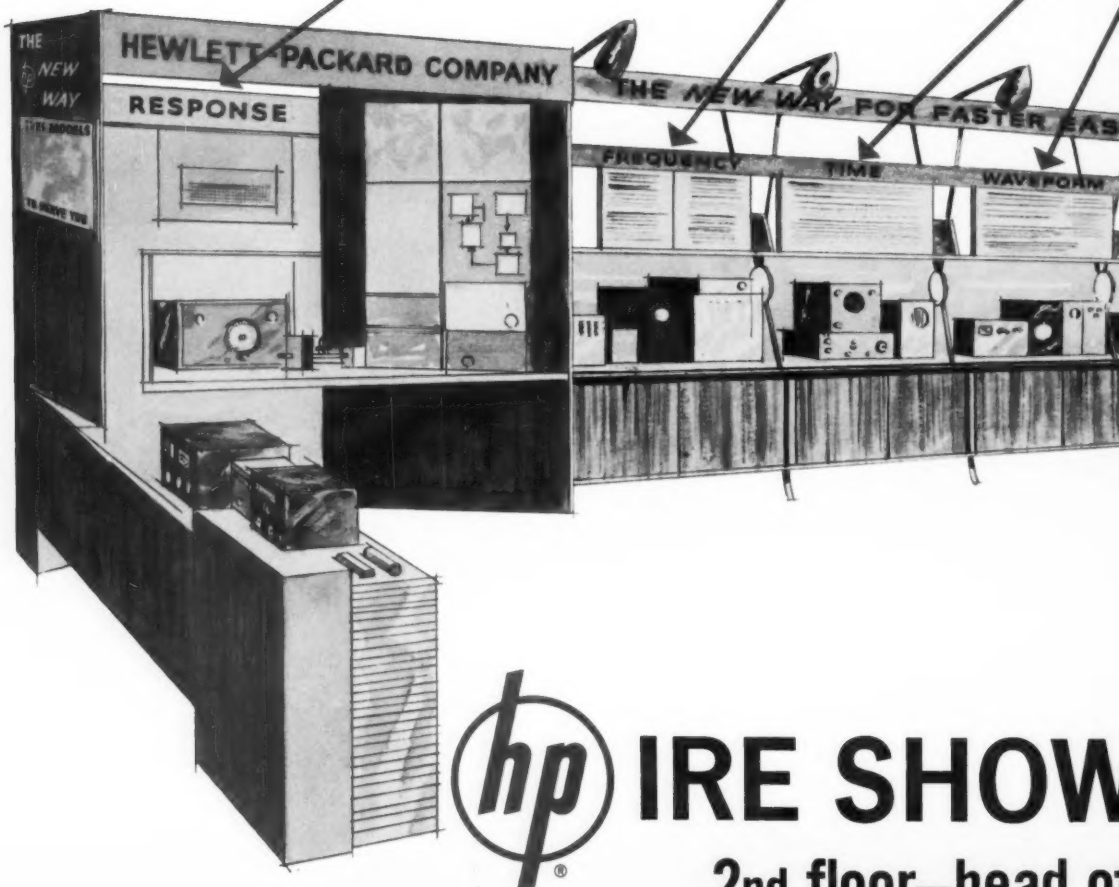
see it...test it at

hp IRE SHOW

2nd floor—head of escalators

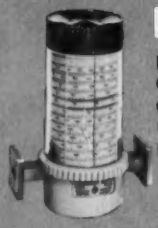
A new way...

new cost-cutting measuring techniques made possible by new-concept hp instruments



hp IRE SHOW

2nd floor—head o

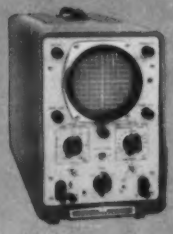


RESPONSE

New electronic sweep oscillators (left). 5 units cover 2 to 18 KMC. Quick, accurate, convenient response measurements of all types of circuits such as masers, parametric amplifiers, TWT's, couplers, attenuators. Also new microwave wavemeters (right), including K and R bands, provide complete coverage 8.2 to 40.0 KMC.

FREQUENCY

Direct, instant, in-line readings; bright, steady numerals on new counters. New reading ease, wide range, improved sensitivity and accuracy.

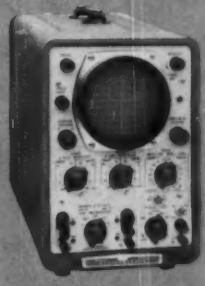


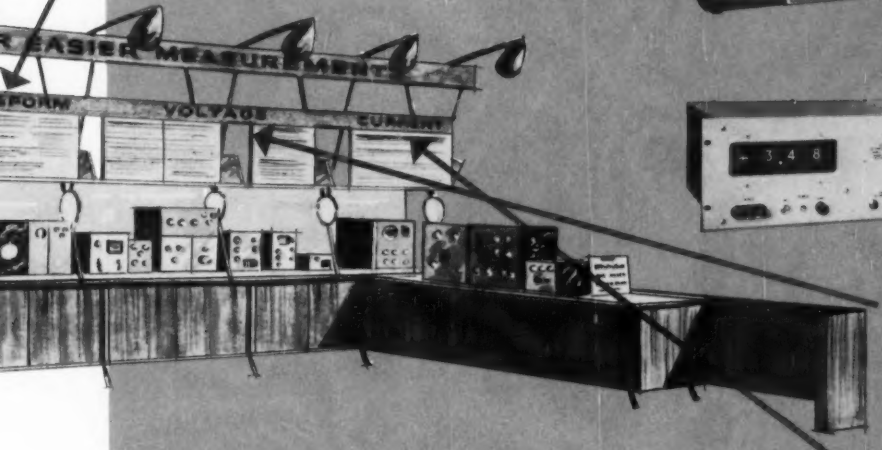
TIME

New clock and divider circuit for control of extremely accurate frequency standards and comparison with station WWV within 10 microseconds accuracy ($1/10^{10}$ accuracy).

WAVEFORM

All-new, transistorized wave analyzer—20 cps to 50 KC, compact, versatile, featuring new control simplicity, new tuning ease, automatic features never before in any wave analyzer. Operating at -hp- display with new low cost, dual trace oscilloscope.





VOLTAGE

New, moderately-priced digital voltmeter providing true "touch-and-read" convenience, automatic range and polarity selection; permits readings to be recorded automatically. Also: new, portable transistorized ac voltmeter.

CURRENT

Revolutionary design approach provides new "clip-and-read" dc current measurement ease—no soldering, no circuit loading, no direct connection. Also new plug-in for -hp- 150A series oscilloscopes permits viewing ac current and voltage simultaneously — ideal combination for transistor circuit testing.

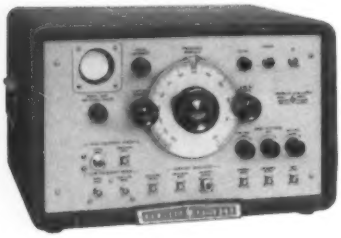
ow

ad of escalators

other ***NEW WAY*** instruments you can see and operate at the hp I.R.E. exhibit

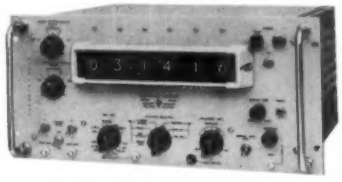
NEW IN-LINE 220 MC COUNTER

New model 524C with plug-ins measures frequency to 220 MC, time interval 1 μsec to 100 days, period dc to 10 KC. New in-line readout, brightly visible under any lighting conditions. Resolution 0.1 μsec, stability $3/10^{8}$ short term, no calculation or complex setup, highest quality; regarded by many as premium commercial counter offered. $2,300.00.



NEW TRANSFER OSCILLATOR FOR hp COUNTERS

Together with hp 524 series counter, measures frequency to 12 KMC quickly, easily, with counter accuracy. Guesswork, trial and error experimentation, expensive setups are eliminated. Measure on pulsed, AM, FM, CW or noisy circuits. Overall accuracy better than 10 times that of best microwave wavemeters; accuracy on clean CW signals is about 1/1,000,000. Stability better than 0.002%/minute. $750.00.



NEW IN-LINE 1.2 MC COUNTER

Model 523C Electronic Counter provides all-purpose versatility plus the time-saving convenience of bright, steady in-line readout. Measures frequency 10 cps to 1.2 MC, time interval 1 μsec to 27.8 hours, period 0.00001 cps to 10 KC. Stability 2/1,000,000 per week. Results displayed in sec, msec, μsec or KC, automatic decimal. Display time variable, accuracy ± 1 count ± stability. Price on request.

NEW PRECISION VTVM

Model 412A is a precision vacuum tube voltmeter providing measurements from 1 mv to 1,000 v full scale, with accuracy of 1%. This remarkable new high-accuracy instrument also measures currents from 1 microampere to 1 ampere full scale with 2% accuracy, and measures resistances 0.2 ohms to more than 5,000 megohms. $350.00.

PRECISION FIXED ATTENUATOR

-hp- 372A series provide fixed standards of attenuation for waveguide measurements for all bands and waveguide sizes from 2 to 40 KMC. Their precise accuracy is not affected by temperature, humidity or other external factors. $100.00 to $375.00.

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If you aren't attending this year, please call your -hp- representative or write direct for information on any new -hp- equipment.

HEWLETT-PACKARD COMPANY

5029A Page Mill Road • Palo Alto, California, U.S.A.
Cable "HEWPACK" • DAvenport 5-4451
Field engineers in all principal areas

CUT COSTS OF TEST EQUIPMENT BY 20% WITH Technical Information Service

Case histories have shown that companies waste up to 20% of their annual expenditures for test equipment.

A prime cause is the failure to make the best buy obtainable because each company did not know the full range of available equipment. Collecting and maintaining complete, timely, and accurate product information is difficult—could cost as much as $25,000 a year to service—and yet could be incomplete and inaccurate.

A prodigious number of crucial engineering and purchasing man-hours are squandered in test equipment procurement. Tracking down sources of supply takes days and, often, weeks. Key personnel are trapped by protracted correspondence and sales interviews while obtaining full specifications and prices. When modifications are involved, workloads increase geometrically. This costly routine must be repeated every time new purchases are made.

Now, for the first time, you can plug these hidden profit leaks through the use of a completely new concept in instrument evaluation for procurement.

Technical Information Service (TIS) provides you with complete, timely product information about *all* available electronic test equipment. In a matter of minutes you can possess detailed descriptions of equipment produced by every manufacturer in the business, from the largest to the smallest, without bias in favor of either. What's more, the descriptions include the *full specifications,* price, and the names and addresses of local sales representatives—all you need to initiate procurement.

Consider the benefits enjoyed by clients of Technical Information Service.

SINGLE SOURCE OF SUPPLY INFORMATION

Clients have the only central source of supply information designed specifically for their electronic test equipment requirements. Completely categorized, up-to-the-minute information makes the user a technical expert capable of quickly evaluating complete spec-by-spec comparisons of competitive equipment. Since TIS maintains accurate files by constant check of all sources for additions and changes in specifications and prices, clients may make inquiry by phone or letter on any test instrument problem at any time.

With such information at their fingertips, clients can make their purchases with total awareness of what the market has to offer. Procurement is made with minimal demands on key personnel and their time. Many clients find that this accelerated purchasing procedure has earned an extra bonus in expediting tight-schedule projects for which the test equipment is needed.

COMPLETE, ACCURATE INFORMATION

Clients receive detailed data on more than 4,500 separate instruments manufactured by some 400 different companies. Constant review of the entire instrument field by graduate engineers keeps data on specifications, prices, and models up to date at all times. Suppliers are queried on incomplete or dubious information, if necessary, before their products are included in any TIS release.

Since all products are described without charge and without advertising claims, small and large manufacturers are on equal footing. Their instruments speak for themselves with bald facts, free of slanted claims or persuasive case histories. Clients make their own evaluations from complete, factual information.

SUPPLIER RESEARCH SERVICE LOCATES "CUSTOM" INSTRUMENTS

Often, seemingly built-to-order requirements can be satisfied by minor modification to standard instruments. The complete listing of all large and small manufacturers of stock items provides a ready reference for such inquiry, either directly by the client or through the efforts of TIS.

In those cases where unique equipment is a necessity, TIS Supplier Research surveys the market for the client, collecting all the pertinent information he requires to initiate serious negotiations with suppliers.

COMPLETE PRIVACY

Whether TIS is locating sources for unique requirements or providing information on standard equipment, clients maintain a cloaked identity during all stages of inquiry. The Client conducts negotiations with the suppliers in whom he is interested.

FOUR-VOLUME DIRECTORY

Clients of the tax-deductible Technical Information Service receive a free, four-volume, handsomely bound encyclopedia of standard equipment and sources published twice a year and supplemented constantly. Three volumes are devoted to descriptions of equipment. The fourth volume is an extensive cross-index of manufacturers and their representatives. Completely free of advertising, the directories give clients a complete, factual picture of all standard electronic test instruments. Clients of Technical Information Service receive both the Directories and Supplier Research Service.

PROVEN IN USE

For the past two years TIS has served such clients as General Electric, M.I.T., Lincoln Labs., General Motors, NASA, Litton Industries, Naval Ordnance Lab., Hewlett-Packard, Lockheed Aircraft, Western Electric, RCA, Marconi Instruments, Eglin AFB, American Bosch Arma, and hundreds of others. The merit of TIS is proven by the fact that many clients have contracted additional service for other departments and projects.

SAMPLE TIS AT THE IRE SHOW—FREE!

Judge the value of TIS by personal experience. See TIS in operation at the IRE Show. Stop at Booth 4431 to check a product requirement. See how TIS can save as much as 20% of your annual expenditure on test equipment. See how TIS can reduce the hidden costs of instrument procurement. If you are unable to attend the IRE Show, fill in the coupon below.

VOL. I—Sources • VOL. II—Modifiers • VOL. III—Scalers
VOL. IV—Index of Manufacturers and Representatives

Technical Information Corporation
41 Union Square, New York 3, New York, WAtkins 4-2111

I cannot stop at your booth at the IRE Show, but I am interested in Technical Information Service. Please send me complete information about it.

NAME_____ TITLE_____

DEPARTMENT_____ COMPANY_____

ADDRESS_____

←CIRCLE 51 READERS SERVICE CARD CIRCLE 52 READERS SERVICE CARD

From SPERRY...

6 New Traveling Wave Tubes Combining Broad Frequency

New in design and new in performance, this line of Sperry traveling wave tubes presents frequencies from 240 to 11,000 mc—together with high power for amplifier service in microwave systems. Particularly suitable for cw radar and communications, their characteristics listed below will suggest their use for many other applications.

Data sheets on any or all of these new tubes are yours upon request. There are two electronic tube facilities to serve you: Sperry Electronic Tube Division

STP-49

STL-48

STL-100

CHARACTERISTICS			
Frequency Range	240 to 510 mc	500 to 1000 mc	1000 to 2000 mc
Rated Output Power (CW)	200 w (min)	200 w (min)	200 w (min)
Input Power at Rated Output Power	500 mw (max)	500 mw (max)	200 mw (max)
Small Signal Gain	30 db (min)	30 db (min)	32 db (min)

CIRCLE 53 READERS SERVICE CARD

Range With High CW Power

of Sperry Gyroscope Company, Great Neck, N.Y. and Sperry Electronic Tube Division of Sperry Rand Corporation, Gainesville, Florida.

You can see all these tubes at our booth 1410-1416, 1959 Radio Engineering Show, March 23-26.

SPERRY

BOSTON
BROOKLYN
LOS ANGELES
PHILADELPHIA
SAN FRANCISCO
SEATTLE

STS-101

STX-104

STX-105

CHARACTERISTICS		
2000 to 4000 mc	7000 to 8750 mc	8650 to 11,000 mc
200 w (min)	100 (min)-150 w (Av)	100 (min)-150 w (Av)
200 mw	630 mw (max)	630 mw (max)
40 db	40 db (nom)	40 db (nom)

CIRCLE 54 READERS SERVICE CARD

Actual size,
3-inch ultrahigh-resolution tube

Now... 262 Square Inches of information in $\frac{1}{20}$ Square Inch!

New CBS-Hytron ultrahigh-resolution tubes, for example, can compress into 0.047 square inch all the detail on a 21-inch picture tube screen. This is twice the resolution previously attainable . . . resolution far beyond the capabilities of the unaided human eye and modern printing. And the closest yet to the resolution of modern photographic film.

MANY APPLICATIONS NOW POSSIBLE Many new and advanced applications become practical in strip radar • photo reconnaissance • visual indication • photo reproduction • information transfer • industrial and medical closed circuit TV • remote data pick-up • information conversion • etc.

12 CBS-HYTRON UHR TUBES IN PRODUCTION

These tubes offer a choice of four resolution levels . . . three screen sizes . . . and three screen phosphor characteristics. They are even more rugged and dependable than standard oscilloscope tubes. And they can be supplied with interchangeable yoke, focus coil and video driver stage to achieve maximum resolution. Check the table for summary data. Write for complete technical Bulletin E-330 and information regarding your particular application.

TYPE NUMBER	RESOLUTION (Lines per Inch)	SPECTRAL COLOR	PERSISTENCE TIME
3AVP5	1500	Blue	Very Short
3AVP11	1000	Blue	Short
3AVP16	500	Near UV	Very Short
3AWP5	2000	Blue	Very Short
5CQP5	1500	Blue	Very Short
5CQP11	1000	Blue	Short
5CQP16	500	Near UV	Very Short
5CRP5	2000	Blue	Very Short
7AVP5	1500	Blue	Very Short
7AVP11	1000	Blue	Short
7AVP16	500	Near UV	Very Short
7AWP5	2000	Blue	Very Short

More reliable products through Advanced-Engineering

CBS tubes

CBS-HYTRON, Danvers, Massachusetts
A Division of Columbia Broadcasting System, Inc.

Television Trains Missilemen

Closed-circuit program now links Alabama and Kentucky, may spread to 46 states

CLOSED-CIRCUIT TV is carrying missile instruction programs from Redstone Arsenal, Huntsville, Ala., to Ft. Knox, Ky., in a project that may be extended to installations in 46 states.

Center of the military educational hookup is the Ordnance Guided Missile School (OGMS) at Redstone Arsenal. Programs are carried north to classrooms in Ft. Knox where they are seen simultaneously by 26 study groups over large-screen projector tv systems.

Less Expensive

OGMS was chosen as hub of this system because it is the only Army school devoted exclusively to guided missile training. Permission for tv transmissions was given by Secretary of the Army because tv proved to be a far less expensive method of training personnel than earlier attempts to transport equipment and instructors from one military base to another.

Prime contract for the missile school programming was granted to Teleprompter Corp., N. Y., which exercises responsibility for creative control over programming and supplies professional technicians to operate television equipment for the project.

System Details

The OGMS system at the missile school includes a central studio equipped with a pair of RCA image orthicon tv cameras, film, and slide equipment. Fifteen other RCA cameras, both image orthicon and vidicon are installed in five mobile units consisting of specially adapted six-by-six army trucks.

Nineteen tv pickup locations with coaxial cable outlets in weatherproof housings have been installed at key points throughout the training base.

These enable tv crews to provide a full range of indoor and outdoor coverage.

Checking Gear Inside the Thor

Electronic stabilization section of Air Force's Thor IRBM is inspected by Donald W. Douglas, Jr. (right) president of Douglas Aircraft, and James Bell, director of Navigation and Guidance at AC Spark Plug. Thor's is first mass-produced inertial guidance control system

Whatever your coaxial cable needs—for electronic equipment, for military applications, or for community TV installations—Royal's electronic cable production lines are ready to fill your requirements NOW.

For a quick look at the Royal Coaxial Cable line, request Bulletin No. 4C-3-L.

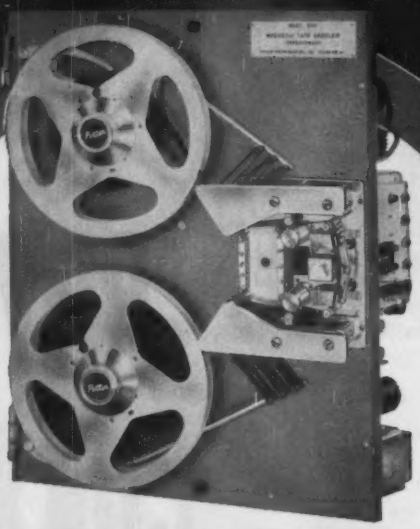
* Formerly manufactured by Federal Telephone & Radio Company

ROYAL ELECTRIC CORPORATION
301 Saratoga Avenue
PAWTUCKET • RHODE ISLAND

ROYAL ELECTRIC
...an associate of

CIRCLE 56 READERS SERVICE CARD

New Speed...Versatility...Reliability...



TRANSISTORIZED DIGITAL MAGNETIC TAPE HANDLER MODEL 906

• Check these new standards of reliability and performance

- Completely transistorized for maximum reliability
- Trouble free brushless motors
- Over 50,000 passes of tape without signal degradation
- Linear servo system
- Life expectancy of pinchroll mechanism: over 100,000,000 operations
- Skew ±3 μsec. ½" tape, center clock at 100 i.p.s.
- Vacuum loop buffer
- Continuous flutter free cycling 0 to 200 cps
- Normal speed up to 100 i.p.s.
- Rewind or search speed constant at 300 i.p.s.
- Six speeds forward or reverse up to 150 i.p.s.
- Better than 3 milliseconds start, 1.5 millisec. stop
- Front panel accessibility
- In line threading
- End of tape and tape break sensing
- All functions remotely controllable
- Tape widths to 1¼"

The 906 is usually supplied with the Potter 921 transistorized Record-Playback Amplifier; a unit that features:

Pulse or level outputs

Output gating 1 i.p.s. to 150 i.p.s.

Manual, relay, or electronic function switching

Dual read-write operation

Potter also manufactures a complete line of Perforated Tape Readers, High Speed Printers and Record-Playback Heads.

Contact your Potter representative or call or write direct for further information.

See us at the I.R.E. Show—Booths 1912-14

Potter

The mark of Engineering Quality

POTTER INSTRUMENT COMPANY, INC.
Sunnyside Boulevard, Plainview, N. Y.
OVerbrook 1-3200

Potter has career opportunities for qualified engineers who like a challenge, and the freedom to meet it.

MEETINGS AHEAD

Mar. 12-13: Canadian Aircraft Industry Instrumentation Symposium, I.S.A., Lord Simcoe Hotel, Toronto.

Mar. 15-18: National Assoc. of Broadcasters, Annual Convention, Conrad-Hilton Hotel, Chicago.

Mar. 23-25: Flight Testing Conf., American Rocket Society, Daytona Plaza and Princess Issena Hotels, Daytona Beach, Fla.

Mar. 23-26: Institute of Radio Engineers, IRE National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

Mar. 31-Apr. 2: Millimeter Waves Symposium, Polytechnic Inst. of Brooklyn, USAF, ONR, IRE, USA Signal Research, Engineering Societies Bldg., New York City.

Apr. 1-May 6: Transistor Circuits Workshop, Six Weekly Evening Sessions, IRE, Hancock Hall, Boston.

Apr. 5-10: Nuclear Congress, sponsored by over 25 major engineering and scientific societies, Public Auditorium, Cleveland.

Apr. 6-7: Astronautics Symposium, Air Force Office of Scientific Research, Sheraton-Park Hotel, Washington, D. C.

Apr. 6-9: British Radio and Electronic Components Show, Great Hall, Grosvenor House, Park Lane, London W.I.

Apr. 13-15: Protective Relay Conf., A & M College of Texas, College Station, Tex.

Apr. 14-15: Industrial Instrumentation & Control Conf., PGIE of IRE, Armour Research Foundation, Illinois Inst. of Tech., Chicago.

Apr. 16-18: Southwestern IRE Conf. and Electronics Show, SWIRECO, Dallas Memorial Aud. & Baker Hotel, Dallas.

Apr. 20-21: Analog & Digital Recording & Controlling Instrumentation, AIEE, PGIE & PGI of IRE, Bellevue-Stratford Hotel, Philadelphia.

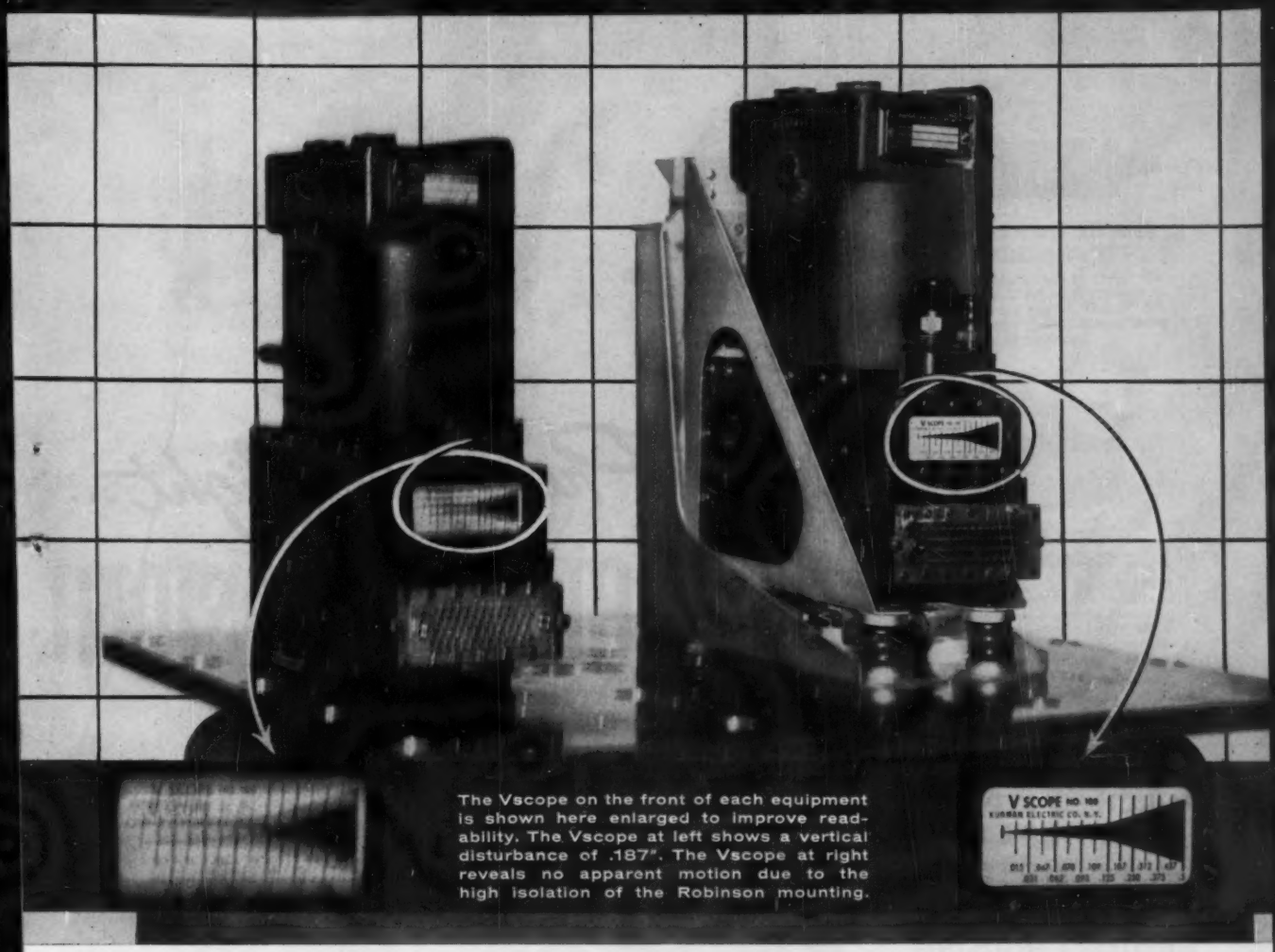
Apr. 20-22: Instrument Society of America, Southeastern Conf. & Exhibit, Gatlinburg, Tenn.

Apr. 20-22: Man-in-Space Conf., American Rocket Society, Hotel Chamberlain, Hampton, Va.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 162.

CIRCLE 57 READERS SERVICE CARD

CIRCLE 58 READERS SERVICE CARD→



The Vscope on the front of each equipment is shown here enlarged to improve readability. The Vscope at left shows a vertical disturbance of .187". The Vscope at right reveals no apparent motion due to the high isolation of the Robinson mounting.

12.0 "G" reduced to 0.6 "G"

This Is Environmental Protection!

Look at the above illustration, showing two Bendix air data sensors on an electromagnetic shake table. Notice the left hand unit which is mounted solidly to the oscillating head of the shaker. The image is blurred because a vibratory input of about .187" double amplitude at 35 c.p.s., equalling an acceleration force of 12 "g's", is being applied directly to it.

Now look at the right hand unit mounted on a Robinson engineered mounting system ... some difference! The clear image of this equipment shows the typically high isolation efficiency (over 95%) of the Robinson MET-L-FLEX® mounting design.

Other Robinson designs provide similar protection at higher frequencies where the input often reaches 30-40 "g's". The natural frequencies of such mounting systems are held within limits which are not critical to the equipment.

Utilizing this mounting system radically reduces the environment to a level easily tolerated by any reasonably well designed electronic equipment. Such a mounting eliminates the need for costly and time consuming ruggedization. Over-all space and weight are held to a minimum.

Because of the proven performance and reliability record of airborne components *now* protected by Robinson mountings, an increasing number of manufacturers in the electronics industry are incorporating Robinson mountings as an *integral part* of their basic equipment design.

"Performance is the reason ... Reliability the Result"

ROBINSON CONTROL IS RELIABILITY CONTROL

ROBINSON AVIATION INC.
TETERBORO · NEW JERSEY

West Coast Engineering Office: Santa Monica, Calif.

DESIGNERS AND MANUFACTURERS OF VIBRATION CONTROL SYSTEMS

Proven in flight...

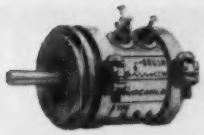
FAIRCHILD PRECISION

FAIRCHILD TYPE 909 MULTI-TURN HAS ALL-METAL • STOPS • SLIDER • ROTOR • HOUSING

There are no phenolic, plastic or other non-metallic materials in the type 909's mechanical components. This rugged, precision ⅞" diameter 10-turn potentiometer offers the utmost in reliability and performance.

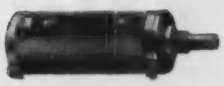
The design can be built with linear as well as non-linear functions. It has low noise, good shock and vibration characteristics and excellent linearity (± 0.5% to ± .05%). Temperature range is —55°C to +90°C standard and to +150°C in high temp version. Several units can be ganged on a common shaft in from 3 to 20 turn configurations.

POTENTIOMETERS



3-TURN High Reliability POTENTIOMETERS

This ⅞" dia. type 906 is one of three sizes offered by Fairchild. All feature exclusive long-life wiper guide mechanism.



10-TURN High Reliability POTENTIOMETERS

Available in ⅜" to 1 3/16" dia. and in 3 different designs to suit your needs. The 1" dia. type 920 shown above takes 30 G's at 2000 cps.

SINGLE-TURN LINEAR AND NON-LINEARS

Type 751 ⅝" dia. is one of 28 different types available in sizes up to 5". Functional accuracy over life is guaranteed — Fairchild's "Safety Factor" for reliability.

SINE-COSINE POTENTIOMETERS

Sizes 1⅛" to 5" dia. Built with Fairchild High Reliability resistance elements featuring top-wiped, shaped card windings which provide higher resolution and conformity regardless of position.

Having missiles fire as predicted is becoming more and more vital to the defense program. The reflection of this is the increased importance of the Reliability factor, or in a phrase the "*Predictable Excellence*", of components.

In the future less business will go to the unproven though low priced producer. Management has learned that the lowest initial cost does not always result in the lowest end cost.

Fairchild's precision potentiometers are *proven performers*. They are flying with *predicted excellence* in the nation's most important missiles and aircraft, some of which are illustrated above. They have a reputation for sustained high accuracy, lowest noise level and long life. As a result, Fairchild Reliability is fast becoming an industry standard.

For example, Fairchild High Reliability pots contain only high temp stabilized materials, welded terminations, and precious metal contacts. They are built to close dimensional and design control. And they are subjected to a continuing inspection and quality control program which includes torture testing 1 out of every 100 production units.

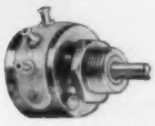
For more information write Dept. 26-E

LINEAR MOTION POTENTIOMETERS

The flexibility of the type 910 design permits 1 or 2 resistance elements, and various stroke lengths. MIL-E-5272A environments are exceeded for the Fairchild Reliability "Safety Factor".

MINIATURE TRIMMING POTENTIOMETERS

⅜" dia. type 926 and ½" dia. type 927 exceeds MIL Std. 202A, rated 150° C. Metal case and precious metal contacts are Fairchild's reliability "Safety Factor".



SINGLE-TURN METAL FILMPOTS

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For rugged environments and temperatures when infinite resolution and unsurpassed reliability is required. Available from stock.

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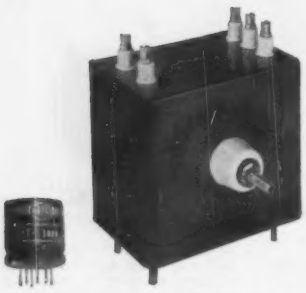
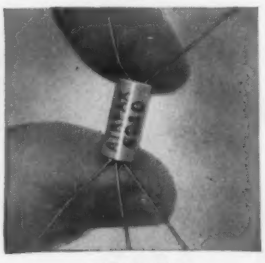


TRANSFORMERS:
FROM MIDGET TO MAMMOTH



ACTUAL SIZE
TRANSISTOR CHOPPER

LOW NOISE CHOPPER

MAGNETIC CIRCUIT BREAKER

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MOLDED
MAGNETIC DC AMPLIFIER

Airpax is proud to display these fine components for the critical inspection of Electronic Engineers. Built into each device is the integrity of the Airpax organization. Every component leaves the plant with an unquestioned ability to meet and surpass rigid specifications.

"Airpax" and "Choppers" have long been synonomous. The low noise type was released only after proving its right to such terminology. The recently announced transistor chopper was subjected to exhaustive engineering tests before being marked "Airpax." The magnetic Circuit Breaker is new—it has characteristics which might be expected of devices many times its size. Magnetic units—the Tach-Pak, a tachometer package capable of measuring frequency with an accuracy of ¼ of 1% and the newly announced line of molded Ferrac magnetic amplifiers are designed and produced in accordance with exacting Airpax Standards, as are all transformer products.

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MERCK DOPED SINGLE CRYSTAL SILICON—offers doped float zone single crystals of high quality at low costs. Yields of usable material are reported to be especially high when device diffusion technics are used with these crystals. Float zone single crystals doped either "p" or "n" type with resistivities from 3 to 300 ohm cm. any range plus or minus 25% and a minimum lifetime of 100 microseconds are available in diameters of 18 to 20 mm., and random lengths of 2 to 10 inches.

NOTE: *Doped single crystals in other diameters, resistivities, or lifetimes not listed above can be furnished as specials.*

MERCK HIGH RESISTIVITY "P" TYPE SINGLE CRYSTAL SILICON—offers float zone single crystals of a quality unobtainable by other methods. Available with minimum resistivity of 1000 ohm cm. "p" type and a minimum lifetime of 200 microseconds, diameter 18 to 20 mm., random lengths 2 to 10 inches.

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- SUPRAMICA 560 ceramoplastic (932°F. precision-moldable insulation)
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on a 3 inch precision-molded plate ...up to 540 rectangular contacts!

Since 1948 . . . when Mycalex Electronics Corporation pioneered the first *precision-molded* MYCALEX® 410 glass-bonded mica, 180-contact commutator plate . . . MYCALEX switches have introduced a degree of accuracy and dependability never before approached in mechanical switching.

And now, Mycalex offers a *new* ceramoplastic commutator plate design destined to set *even higher* standards for long-life, low-noise-level multiplexing.

Typical of these new plates is the CP 427. Its specifications call for *precision-molded* SUPRAMICA 555 ceramoplastic which delivers total dimensional stability as well as superb thermal endurance (700°F.). The individual contacts of this plate have an exclusive *rectangular* form and embody tolerances within the .0005″ range. They are permanently fixed in place.

An exclusive brush-holder design permits *lower pressures* on the wipers . . . gives *lower contact resistance* with a noise level of *less than 10 microvolts*. Brush bounce is eliminated and life greatly extended. MYCALEX switches using this type of design have been tested satisfactorily for over 1000 hours at 600 RPM without maintenance.

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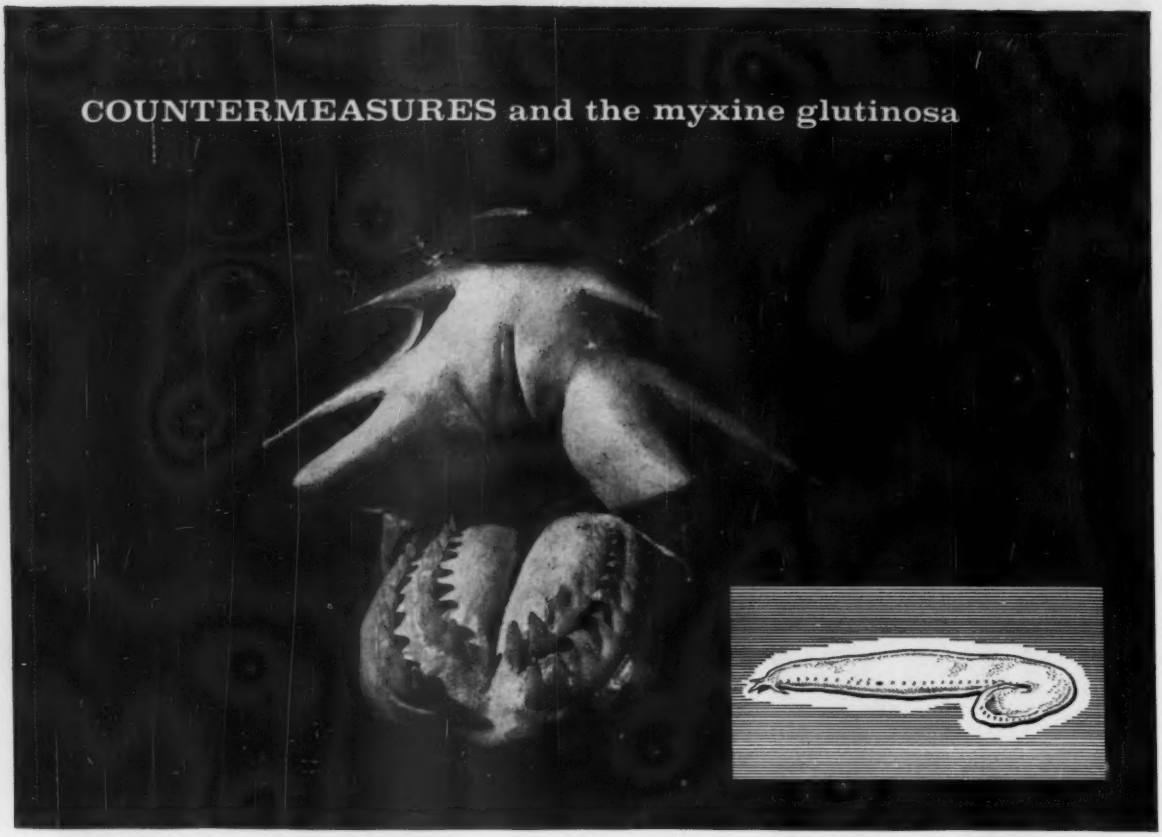


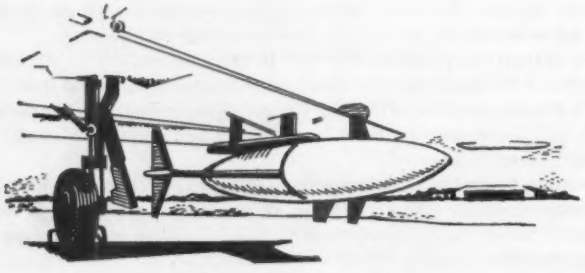
FORMIDABLE, INDEED, IS THE HORRENDOUS HAGFISH

though small in size, his capabilities are enormous...

Seventeen inches of devastating destruction are represented in the pictures above. Appearing to be no more than another small eel, this specimen can, in a matter of hours, eat his way through the skin of his victim and then proceed to devour everything except bone. Things are not always what they appear...a theme common to countermeasures .

Certain types of countermeasures under development also might be said to have hidden teeth.

A small drone, equipped with devices to make it appear as one or more bombers when viewed on radar scopes, could very well carry an atomic warhead capable of delivering a devastating blow to a secondary target. Instruments For Industry has for many years been actively engaged in the development and perfection of many types of countermeasures for the Army, Navy, Marines and Air Force. All have reaped the fruits of I.F.I.'s specialized engineering know-how.



First decoy, then destroy

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NEW KLYSTRON POWER SUPPLY

Features Wide Voltage Range, Hi-Power Capacity and Small, Compact Construction

SPECIFICATIONS

	BEAM	REFLECTOR	GRID
Voltage Range	−200 to −4000 v	0 to 1000 v	0 to +150 v 0 to −300 v
Regulation	0.01%	0.01%	0.01%
Max. Ripple	3 mv	3 mv	5 mv
Current	0 to 150 ma (360 w max)	–	5 ma (max)

Power Requirements: 105-125 v, 50/60 cps (also available for 230 volt operation) Dimensions: 11½" W x 20" H x 17½" D Weight: 110 pounds

This new *Microline*® Universal Klystron Power Supply Model 62A1 is a good example of many superior engineering developments coming from the modern Clearwater plant of Sperry Microwave Electronics Company.

Using conservatively-rated components, the Model 62A1 provides a voltage range from 200 to 4,000 volts – meets the needs of nearly every klystron available today, as well as several small cw magnetrons. Internal modulator supplies sawtooth, square wave or sine wave modulation . . . external modulation from either a high or low level outside source is committed through the use of an internal amplifier.

In addition to these advantages, the Model 62A1 requires about one-half the space of the usual power supply – and operating convenience is emphasized by grouping controls for simple, easy adjustment. Write for Microline 62A1 data sheet.

Visit our booth 1410-1416, 1959 Radio Engineering Show, March 23-26.

SPERRY

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New center screwlock connectors for heavy duty applications

from *Continental Connectors*

WITH CLOSED ENTRY CONTACTS

Continental's new center screwlock connectors are designed with high dielectric and mechanical strength for heavy duty applications in aircraft and electronic equipment. Features include a double lead thread screwlock, stainless steel reinforcing channels riveted to plug and receptacle, closed entry contacts and positive polarization through guide pins and sockets. At present the body is molded from glass filled Diallyl Phthalate, but other compounds as well as hoods and protective shells will be available soon.

Closed Entry Socket Contacts are spring temper Beryllium copper, gold plate over silver plate. They provide increased reliability and maintain a low millivolt drop under constant and uniform insertion pressure. Pin contacts are brass with gold plate over silver plate.

For full details on Continental's new Series 1900 center screwlock connectors, write DeJUR-Amsco Corporation, 45-01 Northern Boulevard, Long Island City 1, N. Y. (Exclusive Sales Agents)

You're always sure with **DeJUR** electronic components

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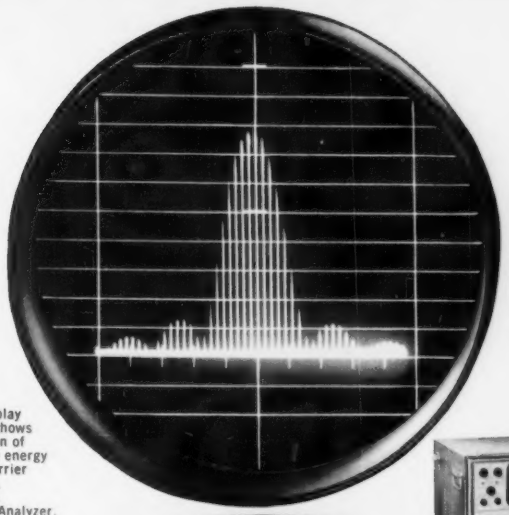
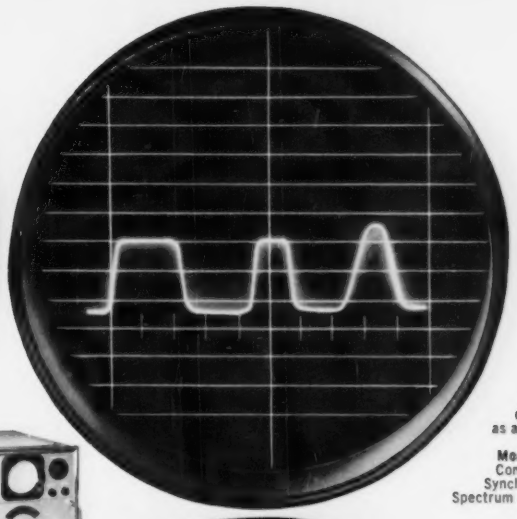
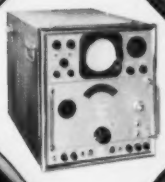
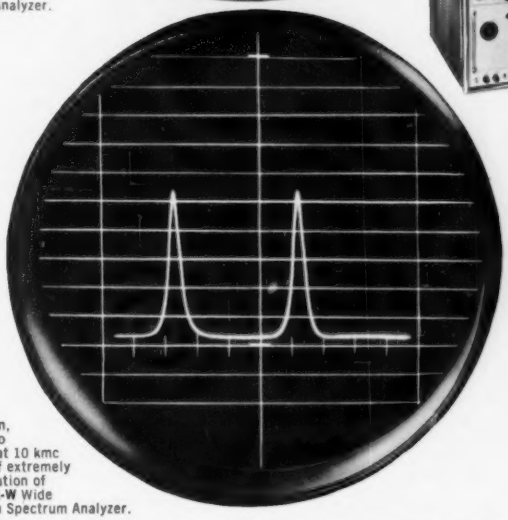


Visual display instantly shows distribution of microwave energy around carrier frequency. **Model TSA** Spectrum Analyzer.

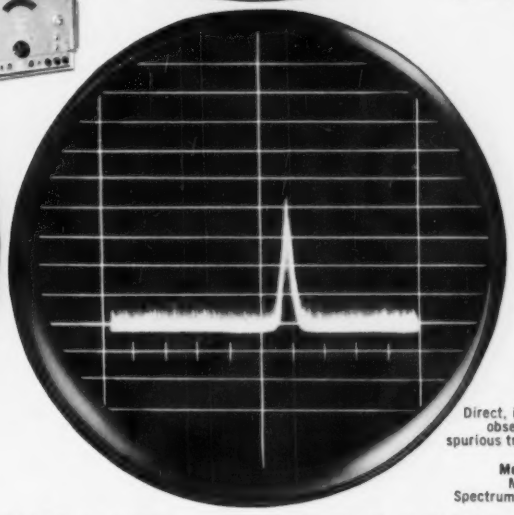


Pulsed signal displayed as a function of time. **Model TSA-S** Combination Synchroscope-Spectrum Analyzer.





Rapid signal comparison, accurate to .00025% at 10 kmc because of extremely fine resolution of **Model TSA-W** Wide Dispersion Spectrum Analyzer.



Direct, immediate observation of spurious transmitter radiation. **Model SA-84** Multi-Band Spectrum Analyzer.

VISUAL MICROWAVE ANALYSIS

4 microwave analyzers cover every application, 10–44,000 mc

MODEL TSA SPECTRUM ANALYZER — 25 kc resolution, 400 kc to 25 mc dispersion. 5 sensitive tuning units.

MODEL TSA-S COMBINATION SYNCHROSCOPE-SPECTRUM ANALYZER — 5 kc to 5 mc adjustable bandwidth, 400 kc to 25 mc dispersion. Time and frequency display. 5 sensitive tuning units.

MODEL TSA-W VERY WIDE DISPERSION SPECTRUM ANALYZER — 7 kc and 50 kc resolution, 100 kc to 70 mc dispersion. Logarithmic amplitude display. 5 sensitive tuning units.

MODEL SA-84 MULTI-BAND SPECTRUM ANALYZER — 10 to 40,880 mc in a single unit.

Polarad spectrum analyzers are basic "scopes" for all microwave work. They display instantaneously such parameters as attenuation, insertion loss and gain, bandwidth characteristics, SWR, frequency, power, etc. In addition they detect and display modulator and transmitter malfunctions such as double moding, misfiring, pushing and pulling by a magnetron, and frequency drift.

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MAIL THIS CARD for specifications. Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes on Microwave Measurements"

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POLARAD E

☐ Microwave Spectrum Analyzers

☐ Model R Receiver (see reverse side of this page)

My application is:_____

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A MULTI-PURPOSE PRECISION TEST INSTRUMENT

DETECTS AND MEASURES:

- Antenna patterns
- Field intensity
- R-F power
- R-F noise figure
- Leakage and interference
- Filter characteristics
- Bandwidth of microwave cavities
- Attenuation
- Insertion gain and loss
- Relative power differences between fundamental signal and harmonics

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PROVEN RELIABILITY

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Now — one basic instrument serves for general communications as well as for detection and complete quantitative analysis of microwave energy.

Polarad Model R Receiver accepts all microwave signals: AM, FM, CW, MCW and pulse. Power and frequency are read directly on front panel indicators.

It permits all standard forms of signal monitoring: special output jacks for audio and video; trigger output to reproduce pulse width and repetition rate; recorder output to transcribe signals through commercial recording equipment.

Model R is simple to operate, extremely sensitive, highly accurate, and is designed for quick, easy inspection and servicing. It provides AFC, AGC, and continuous UNI-DIAL tuning. Eight interchangeable tuning units cover the entire frequency range.

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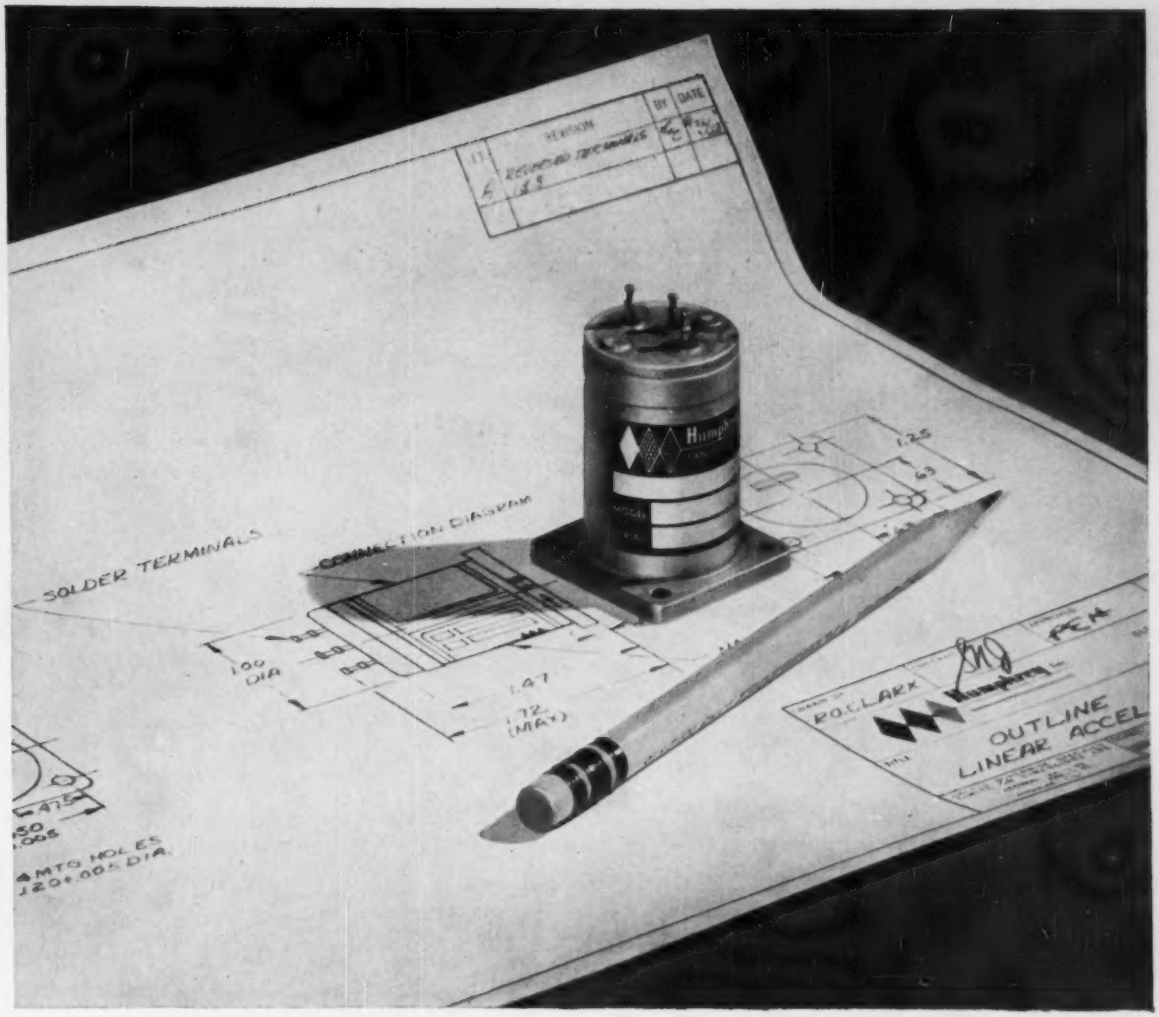

NEW SUB-MINIATURE ACCELEROMETER...

full-size performance in the smallest package yet

This new Humphrey sub-miniature accelerometer with potentiometer pickoff is only one inch in diameter and less than one-and-one-half inches long. It is ideal for precision inertial sensing in minimum space.

UNIQUE DESIGN

This new instrument, known as the LA29-0100 series, employs a unique integral weight and dry-gas damper combination. Simplified design with minimum number of parts reduces cost and improves reliability. It is available in a variety of acceleration ranges and potentiometer characteristics to fit your requirements.

FOR TOUGH ENVIRONMENTS

These accelerometers are hermetically sealed, dry-gas filled instruments containing no plastic or other materials affected by high temperatures. Performance is practically unaffected by temperatures ranging from −75°F to +200°F. Satisfactory performance may be obtained at temperatures to 400°F. The LA29-0100 will operate well under the most severe vibration and shock conditions. Weight is approximately four ounces.

Humphrey welcomes the opportunity to discuss your accelerometer requirements with you. Write or phone today.

Humphrey Inc.
ELECTRO-MECHANICAL INSTRUMENTS

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F-108, NUCLEAR TURBOJET, AND RAMJET PROJECTS OFFER CHALLENGING OPPORTUNITIES TO PROFESSIONAL ENGINEERS AND SCIENTISTS

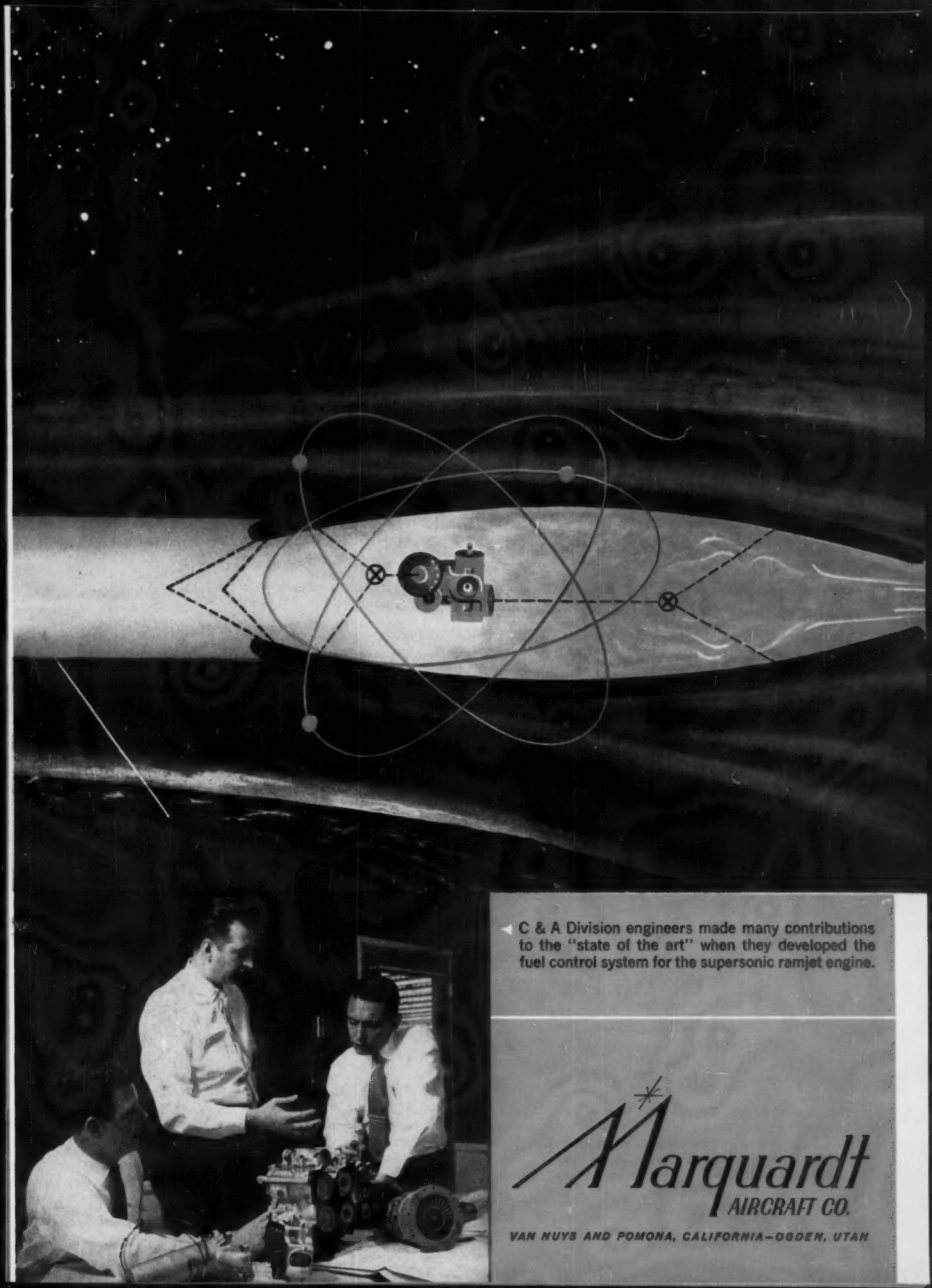
Advanced projects for air and space operations now underway in the Controls and Accessories Division at Marquardt Aircraft offer engineers and scientists challenging opportunities in a variety of technical areas. Here, where we are dealing with development problems on high-performance systems with stringent design and reliability requirements, professional engineers will find real challenge and opportunity for accomplishment.

Project personnel are currently working in such areas as the engine control system for the G-E nuclear turbojet; inlet control systems for the McDonnell F-4H, North American F-108 and the North American Hound Dog missile; the fuel control system for the supersonic Bomarc's ramjet engine; auxiliary power systems, pumps, and actuators; and are developing a unique and advanced space power unit.

C & A Division activities range in scope from preliminary design through final production.

Professional engineers and scientists capable of making contributions in these and related areas are invited to investigate the employment opportunities at Marquardt. You will find a combination of significant, active projects and a lively interest in new ideas, creating an environment for professional growth. May I suggest you write Mr. Floyd Hargiss, Professional Personnel Department, 16555 Saticoy Street, Van Nuys, California?

Roy E. Marquardt, *President*



C & A Division engineers made many contributions to the "state of the art" when they developed the fuel control system for the supersonic ramjet engine.

Marquardt
AIRCRAFT CO.

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BROAD-BAND TRAVELING-WAVE TUBES OF GENERAL LABORATORY ANTICIPATE NEEDS OF ECM AND

Designers of electronic countermeasure and pulsed radar systems are continually making important progress toward equipments with greater flexibility, increased range, improved accuracy and reliability.

Development of low- and medium-power traveling-wave tube amplifiers for these equipments is a major effort at the General Electric Power Tube Department's Microwave Laboratory, Palo Alto, California.

These amplifiers provide wide, instantaneous bandwidths (typical range, 2 to 1) through the use of slow-wave structures having unique helix designs. Active programs include tubes with CW power levels up to 100 watts and above, and pulsed power outputs of several kilowatts. Gains from 25 to 35 db are typical.

The use of permanent magnets and full metal-ceramic construction allows the design of compact, lightweight tubes, able to withstand severe environments found in aircraft and missile applications.

Traveling-wave tube pioneering is only one of the broad range of activities at the General Electric Microwave Laboratory. Active developments in other fields are listed at the right.

All developmental work is done with an eye to practical, economical manufacture —thus minimizing the time lapse between prototype development and quantity production—and to the realistic tube needs of future microwave equipment. Technical inquiries pertaining to advanced tube development invited. *Power Tube Dept., General Electric Co., Schenectady, N.Y.*

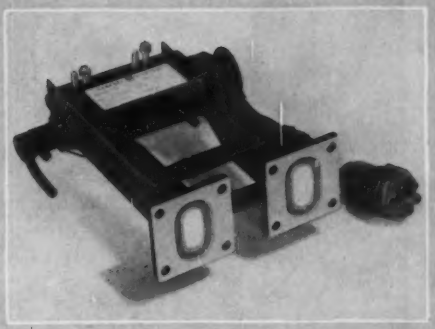
Professional opportunities available for electron tube production, engineering and scientific personnel. Inquiries are invited.

The General Electric Power Tube Microwave Laboratory is located at Stanford Industrial Park, Palo Alto, California where it was one of the Park's pioneer installations. Its scientists and engineers have the advantage of technical exchange with the faculty and research staff of Stanford University, as well as extensive opportunities for graduate training. Constant technical liaison is also maintained with General Electric's own Research and General Engineering Laboratories, Schenectady, New York.

ELECTRIC MICROWAVE PULSED RADAR SYSTEMS

The extensive program of the General Electric Microwave Laboratory on advanced microwave components and techniques includes the following:

- CW Klystron Amplifiers
- Super-Power Klystrons
- Voltage-Tunable Oscillators
- High-Power Duplexers
- Microwave Filters
- Pulse Klystron Power Amplifiers
- High-Power Pulsed TWT Amplifiers
- Low- and Medium-Power CW TWT Amplifiers
- Low-Noise, Broad-Band TWT Amplifiers
- Frequency Multiplier TWT Amplifiers



One of several unclassified designs in advanced development, this 100-watt CW tube features a multiple helix structure, involving four parallel beams for higher power output over a wider bandwidth. Frequency range is 7.5 to 11.3 kmc, with 25 db gain minimum.

Palo Alto engineers responsible for design of low- and medium-power traveling-wave amplifiers discuss tube features for possible use in a final product design. (L. to R.) J. L. Putz (project engineer), G. Van Hoven, L. E. Didier and R. H. Winkler. Parallel groups of engineers are doing similar work on advanced design low-noise and high-power traveling-wave amplifiers.

Progress Is Our Most Important Product

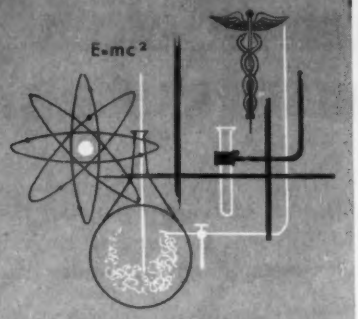
GENERAL ELECTRIC

9845-9481-19

140 KMC

ULTRAMICROWAVE* EQUIPMENT BY

–it works–it's accurate–it's available

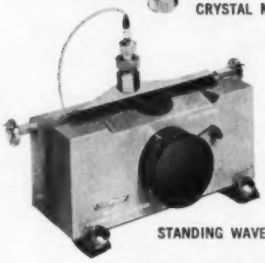


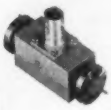
These millimeter wave units can greatly enlarge your scope of microwave activity. Research previously considered impractical at 140 KMC can now be carried on successfully.

De Mornay-Bonardi manufactures cavity wavemeters, crystal multipliers, crystal mounts, E-H tuners, and standing wave detectors specifically for use at 140 KMC. They work – we've been using these units effectively in our own laboratories for developing other items. These instruments are accurate – functionally as accurate as De Mornay-Bonardi equipment used at 90 KMC. You can order these units now – we're currently filling orders on 140 KMC instruments.

Write for complete data

CRYSTAL MULTIPLIERS


STANDING WAVE DETECTORS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*TRADE MARK DE MORNAY-BONARDI

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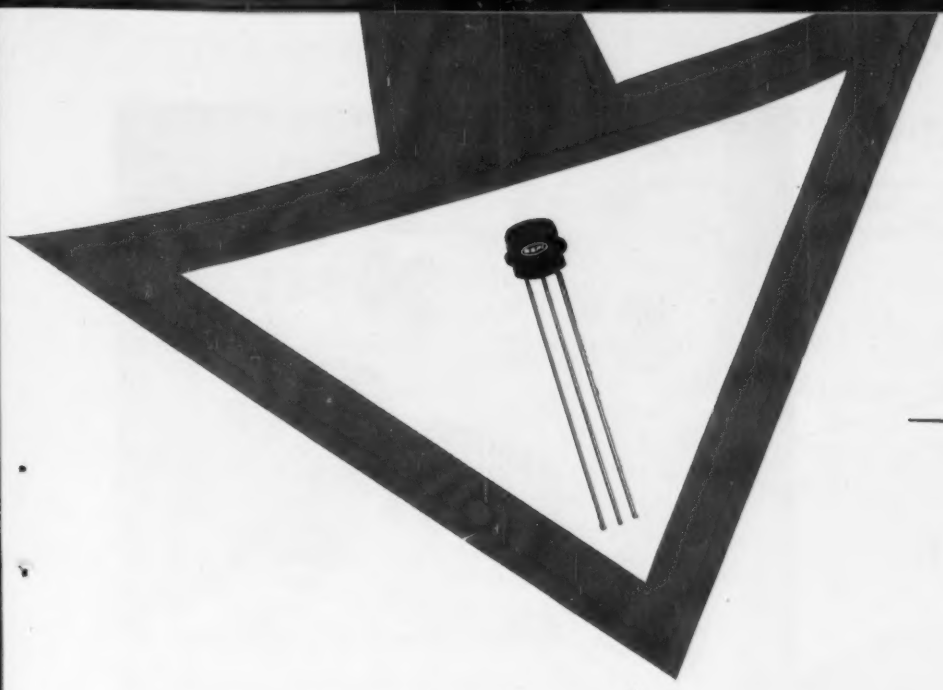

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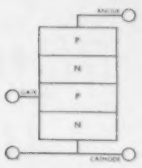


SILICON PNPN CONTROLLED SWITCH

. . . *A completely new semiconductor component* with thyratron-like characteristics for high speed medium power switching

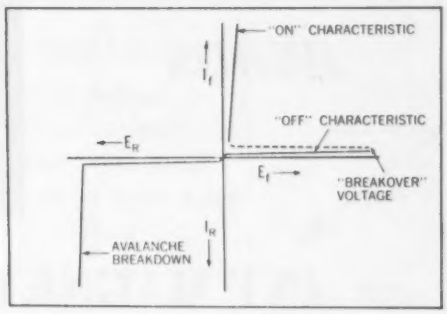
- OPERATING CURRENT RANGE 10 - 1000 mA
- LESS THAN 2 mA GATE CURRENT TO "FIRE"
- VOLTAGE RATINGS TO 200 V
- "TURN ON" TIME TYPICALLY UNDER 0.2 μSEC
- LOW "ON" VOLTAGE, TYPICALLY UNDER 2 V
- OPERATION TO 150° C
- MINIATURE SIZE, IN TO-9 PACKAGE
- MECHANICALLY RUGGED

WHAT THE PNPN SWITCH WILL DO . . . . .

Within their power ratings, the PNPN switches can replace thyratrons, magnetic amplifiers, relays, vibrators, mechanical switches, diodes, transistors and unijunction transistors in a wide variety of applications, including:

Core switching	D.C. motor control
Signal gating	Controlled rectification
Pulse generators	Servo systems
Modulators	Power supplies
Static switching	Power regulation
D.C. to D.C. converters	Choppers
Pulse shaping	Generator field control

Available now through your local SSPI representative or by contacting the factory direct.



The E-I curve above shows the "on" and "off" conditions of the forward characteristic. The switch is turned "on" when a small gate current is applied. When "on" the anode current is limited only by the external load and is independent of the gate current. The inverse characteristic is similar to that of a conventional silicon diode.

A high ratio (up to 500:1) of load current to control current permits high equivalent circuit gain and simplifies control circuitry. Switching efficiencies as high as 98% are possible.

Write for Bulletin C420-01

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"MAGNETIC MATERIALS"

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free.

ADDRESS DEPT. E-15

You can *rely* on core materials like the Allegheny 4750 components illustrated above, in your receivers, recording heads or microphone assemblies.

In fact, whether your equipment is small or large, the extra-broad line of A-L magnetic materials will solve your magnetic core problems. It includes all grades of silicon steel sheets or coil strip, as well as Allegheny Silectron (grain-oriented silicon steel), and a wide selection of high-permeability alloys such as 4750, Mumetal, Permendur, etc.

Our service on these materials also includes complete facilities for the fabrication and heat treatment of laminations. (For users of electrical sheets and strip, our lamination know-how is a real bonus value!) Either way, we'll welcome the chance to serve you. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

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Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON MANUFACTURING COMPANY, WALTHAM 54, MASS., Vol. 1, No. 3

NEW AMPLITRON* BOOSTS L-BAND RADAR OUTPUTS TO MORE THAN 5,000 KW

Extends range to radius of 250 miles at 80,000 feet

Now being incorporated in L-band ARSR systems for the C.A.A., Raytheon's new broad-band QK-653 pulsed-type Amplitron transmits ten times more power than maximum power levels of original RF drivers, increasing the detection range of these systems more than 60%.

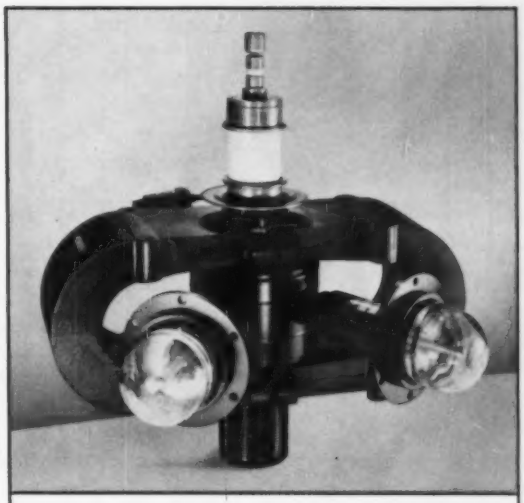
The Amplitron is a highly efficient (50% to 70%) liquid-cooled, integral-magnet microwave tube.

When used with Raytheon's new high-gain 40-ft. antenna, the QK-653 triples the detection range and the warning time of standard long-range search radars.

Non-reentrant RF circuit permits control of oscillation by frequency of RF input over the entire band, 1,280 to 1,350 Mc, at optimum gain and efficiency, without mechanical or electrical tuning. Changes in anode current or voltage have little effect on total phase shift. The Amplitron exhibits excellent reproduction of input spectrum even under high-ripple pulse conditions.

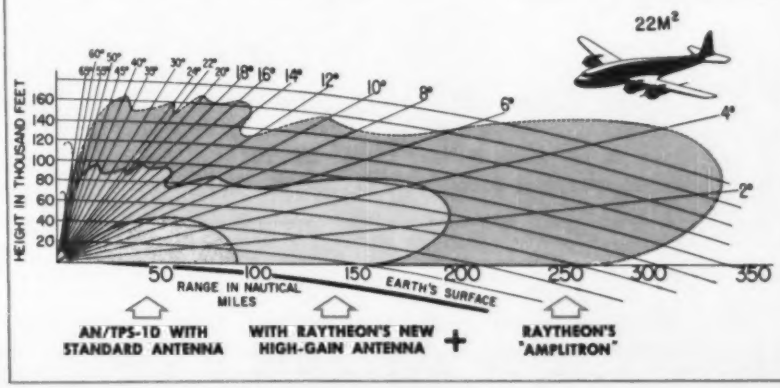
The exceptional phase stability of the QK-653 is particularly advantageous in MTI radar applications.

* Raytheon Trade Mark

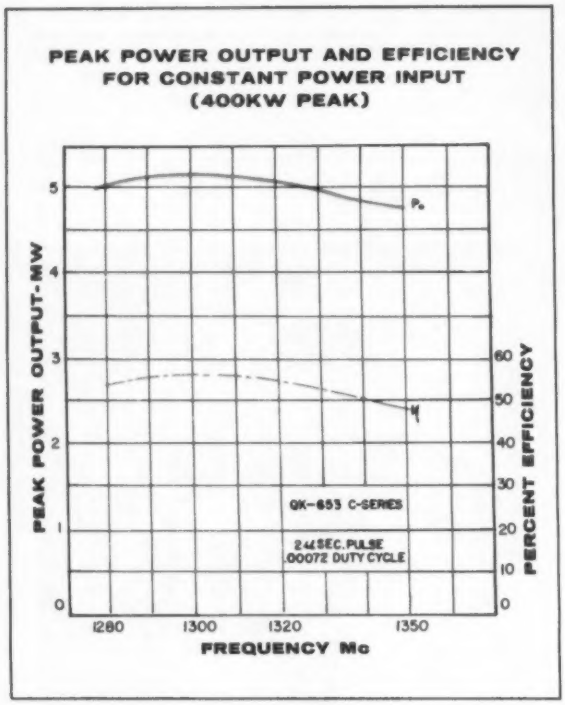


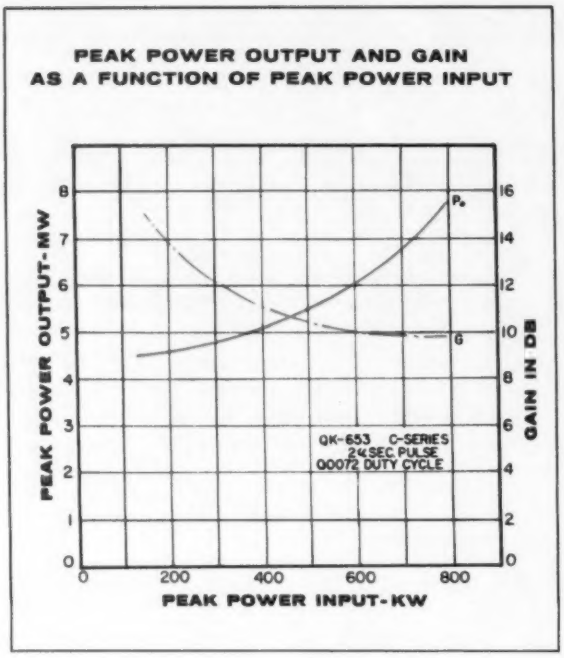
Typical Operating Characteristics

Anode Voltage	94 KV
Anode Current	78 amps
Peak Power Output	4 MW
Average Power Output	2,880 W
Efficiency	55%
Gain	10 db
Operating Band	1,280-1,350 Mc
Peak Power Input	400 KW

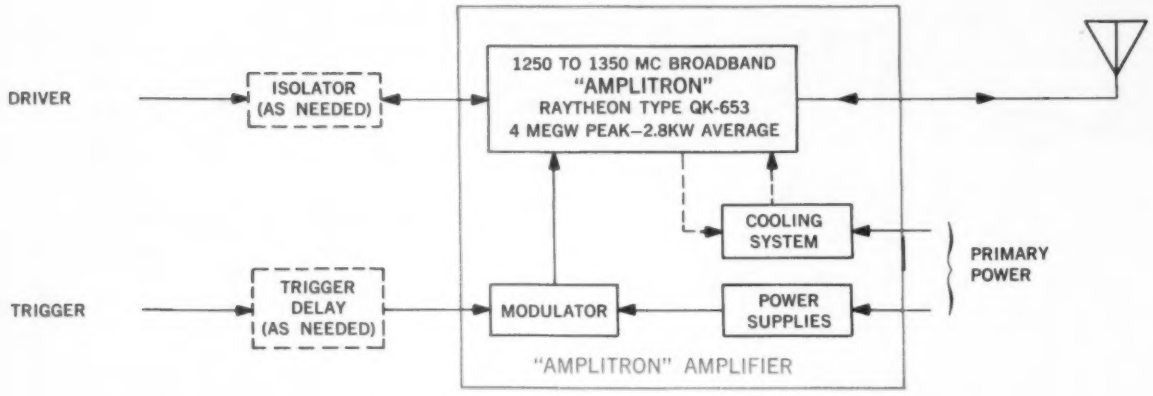


300% increase in coverage and warning time of type AN/TPS-1D radar results when Raytheon's new QK-653 Amplitron and 40-ft. high-gain antenna are added to the system. With other radars of more limited range, improvement factor may be even greater.





Block Diagram of Typical Amplitron Installation



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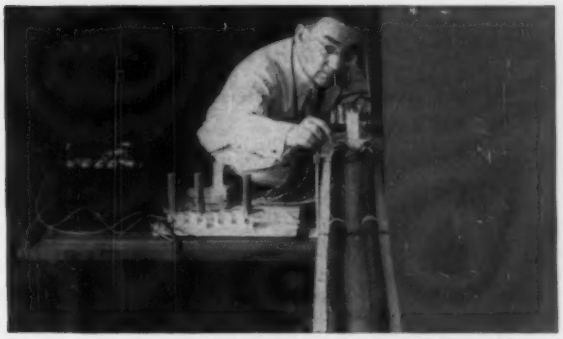
THEY PROBE THE FUTURE OF DEEP-SEA TELEPHONY

"Dry Land Ocean," under construction at Bell Laboratories, simulates ocean floor conditions, is used to test changes in cable loss. Sample cables are housed in pipes which contain salt water under deep-sea pressure. The completed trough is roofed in and is filled with water which maintains the pipes at 37° F., the temperature of the ocean floor.

Deep in the ocean, a submarine telephone cable system is extremely hard to get at for adjustment or repair. This makes it vitally important to find out what can happen to such a system *before* it is installed.

Bell Laboratories engineers do this by means of tests which simulate ocean floor conditions on dry land. Among many factors they test for are the effects of immense pressures on amplifier housings and their water-resistant seals. They also test for agents which work very slowly, yet can cause serious destruction over the years—chemical action, marine borers and several species of bacteria which strangely thrive under great pressures.

Through this and other work, Bell Telephone Laboratories engineers are learning how to create better deep-sea telephone systems to connect America to the rest of the world.



Highly precise instruments developed by Bell Laboratories engineers are used to detect infinitesimal changes in cable loss—to an accuracy of ten millionths of a decibel.

Seawater and sediment in bottle characterize ocean floor. Test sample of insulation on coiled wire is checked for bacterial attack by conductance and capacitance tests.

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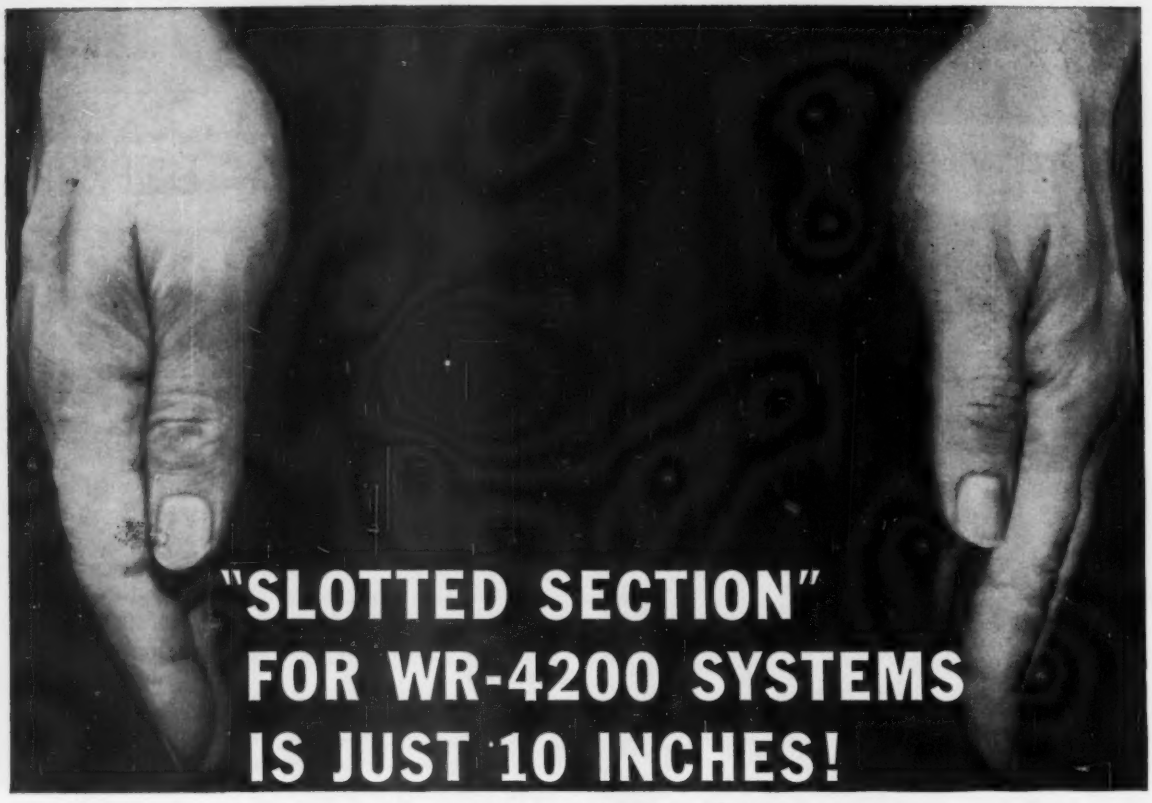


"SLOTTED SECTION" FOR WR-4200 SYSTEMS IS JUST 10 INCHES!

and provides better measurements
and assures more accurate reading of VSWR
and allows direct reading of reflection coefficient angle
and high-power models automatically reject source harmonics

Sound impossible? Not at all. Thanks to a major advance in the science of standing wave measurements!

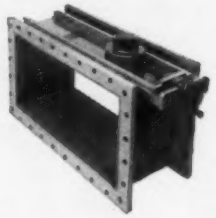
These new measuring devices, called Rotary Standing Wave Indicators, represent a bold solution for VSWR and impedance measurements for *waveguide* and *coaxial* systems from 100 mc/s through 7 kmc/s. The resulting reduction in insertion length alone completely makes *obsolete* the use of slotted sections in this frequency range. The PRD model 223 RSWI (shown here) for use with WR-2100 waveguide systems measures 10 inches as compared with slotted sections measuring over 4 feet!

The PRD Type 219 for use in coaxial systems from 100 to 1,000 mc/s weighs only 4½ pounds and adapts to most types of connectors: Types N, BNC, C, ⅞" coaxial, LT, and TNC.

The waveguide RSWI's are available on special order in two power-handling models: the -LW models are low-power broadband and can handle most laboratory bench-power requirements; the -HN models are high-power 12% bandwidth units and can operate under kw and megawatts of power. All the RSWI's are available for use in waveguide systems from WR-159 through WR-4200.

Specifications and details for the waveguide RSWI's can be found on page H-5 of the latest PRD catalog, E-8. Specs and data for the PRD Type 219 can be found on page B-13. If you do not happen to have ready access to this 160-page reference manual, a complimentary copy can be obtained through your local PRD representative or by dropping us a line on your *company letterhead.*

Complete information on the principles of rotation of a probe in the circular plane of polarization and a full, technical description of the Rotary Standing Wave Indicators are contained in the latest PRD REPORT, VOLUME 6, Number 1. For your free copy send your request to:



Type 223-LW Waveguide Rotary Standing Wave Indicator for standing wave and reflectivity measurements in WR-2100 waveguide systems over the frequency range from 350 to 530 mc/s. Residual VSWR less than 1.03.

Type 219 Rotary Standing Wave Indicator for use in coaxial systems for standing wave and reflectivity measurements over the frequency range from 100 to 1,000 mc/s. Residual VSWR less than 1.03.

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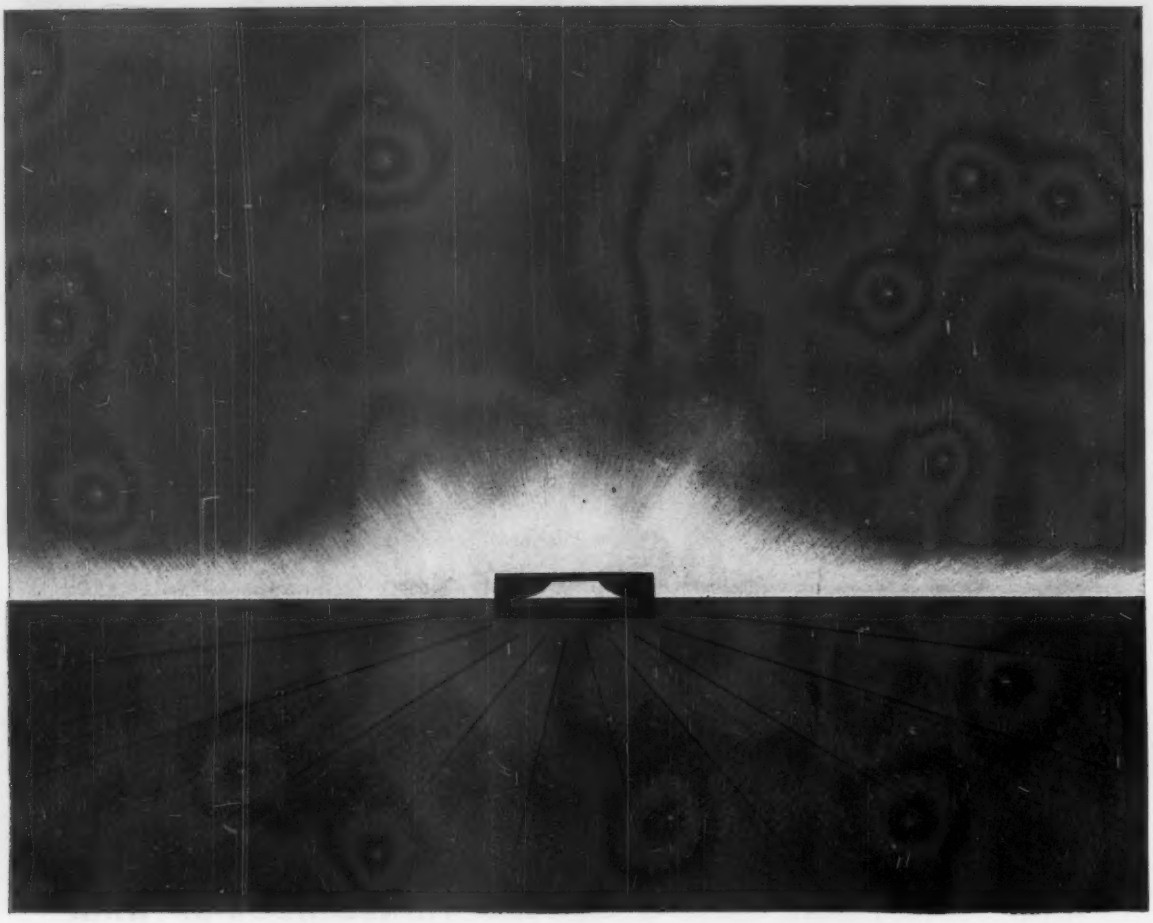

The case of the *missing* mesa . . .

Mesa, mesa, who's got the mesa transistor? Recent announcements have created industry-wide excitement and confusion—and the inevitable disappointment of delayed delivery. What is the true status of mesa? Does it belong to any one or two companies and why is it so hard to get? The circuit designer has good cause to ask these questions, and we'd like to make our contribution to industry enlightenment.

Mesa is such a major development, it can only belong to the industry at large. Some experts feel that mesa will soon supplant most other transistor types in most applications. Certainly its potential is broad, and the barriers it unlocks are many.

At Sylvania, we share this enthusiasm. The mesa transistor is one of our top priority programs—as it is with most manufacturers of major industry stature.

Our pilot runs on amplifier, mixer, oscillator, and switching types have been most gratifying. And we're proud that we are developing new manufacturing techniques which will make the mesa commercially practical.

While none of our pilot runs have yet been sampled to our customers, at this point we are satisfied that we've avoided the disappointments of broken promises. We are not in any race to be first with false starts—rather our objective is to get mesa off to the right start.

We will be announcing availability of commercially practical mesas later this year. If you would like to be one of the first to hear, drop us a note or call one of our sales offices.

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Electrical Indicating Instruments by
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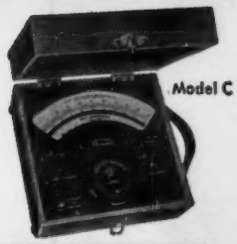
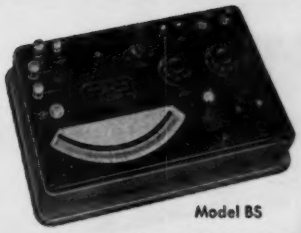
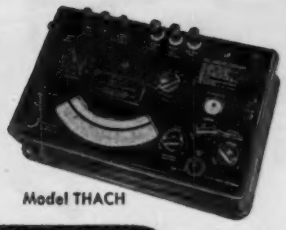

Model C

POLYRANGERS

Multirange DC Reference Standard .25% accurate current and voltage measuring instrument. 14 ranges from 1.5 ma. and 3V. to 3 amps. and 750 V. 6.3" scale length. Other Polyrangers with as many as 88 ranges self-contained available for AC or AC-DC use.


Model BS


Model THACH

LABORATORY STANDARDS

"Self Checking" DC Volt-Amp-Milliammeter. .05% accurate. 12" vernier scale. 25 full scale ranges from 1.5 ma. and .3 V. to 15 amps. and 1500 V. Internal standard cell. Other DC laboratory standards available with an accuracy of .1% and full scale ranges starting from 30 microamps or 50 mv.

"Self Checking" Volt-Amp-Milliammeter. Accuracy .2% DC and AC 7 cps — 4 kcps. 6.3" scale length. 19 full scale ranges from 10 ma. and 1 volt to 5 amps. and 1000 V. Internal standard cell. Other AC standards available with an accuracy of .1% with full scale ranges from 10 ma. and 10V.

Model INCRE

INCREMETER

Direct reading DC electrical indicating instrument. Effective scale length of 63". Accuracy .05%. Each 10% of the instrument's range is expanded over its actual 6.3" full scale length. Single or multiranges from 200 mv. to 1000 v. and 200 microamps. to 10 amps., in either portable or panel mounted models.

Model FM

FLUXMETERS

Single or multirange. Basic sensitivity 10,000 maxwells per division using a single turn search coil. Accuracy .5%. 5.2" scale length. Available with general purpose 10 turn search coil with a mean area of 8 square centimeters.

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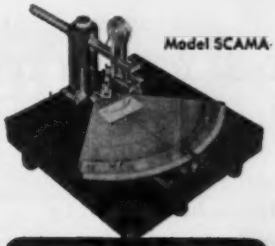
CREST VOLTMETERS

Measures RMS, positive and negative peaks of 10 per second or faster. Basic instrument is electrostatic voltmeter with accuracy of 1%. Ranges up to 100 KV. full scale. Input impedance 10,000 megohms. For AC or repetitive pulsed DC.


Model SCAMA

SCALE MACHINE

For the accurate drawing or redrawing of any laboratory standard electrical indicating instrument's scale whose arc is no greater than 110 degrees. Adapter to 270 degrees available for circular-scale instruments.

Model RFV

VOLTMETERS

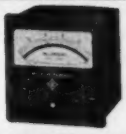
True RMS responding. Full scale ranges from 1 V. to 300 V. Accuracy .5% on DC to 1 megacycle. Usable up to 10 megacycles. Other thermocouple instruments available for all current and voltage measurements.

Model UTS

TEST SETS

Replaces over 200 individual DC current, voltage and resistance measuring instruments. Accuracy .5%. Contains 3 instruments that may either be a millivoltmeter, voltmeter, milliammeter, or ammeter, and 1 microammeter. Portable. Other test sets available for AC and magnetic testing.

Model UPP



Type EW

PANEL INSTRUMENTS

AC and/or DC edgewise panel instruments with the same electrical specifications as Reference Standard portable models. Accuracies to .25%. Scale lengths to 7". Up to eight ranges switch controlled and self-contained. Full scale ranges start from 1 microamp or 1 mv. DC and 1 ma. or 200 mv. AC.

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Laboratory Standard and Reference Standard Portable and Panel Instruments that have earned Sensitive Research the reputation of *"Those Standards People."* All instruments have individually calibrated, hand drawn mirrored scales. Available with the now world famous SRIC *"Diamond Pivot"* and *"Shock Mounted Jewel."* Not pictured above, but available, are a complete line of: Wattmeters • Thermocouple Instruments • Electrostatic Voltmeters • Differential Galvanometers • Ratiometers • Corrosion Instruments. *Write for Catalog No. 70.*

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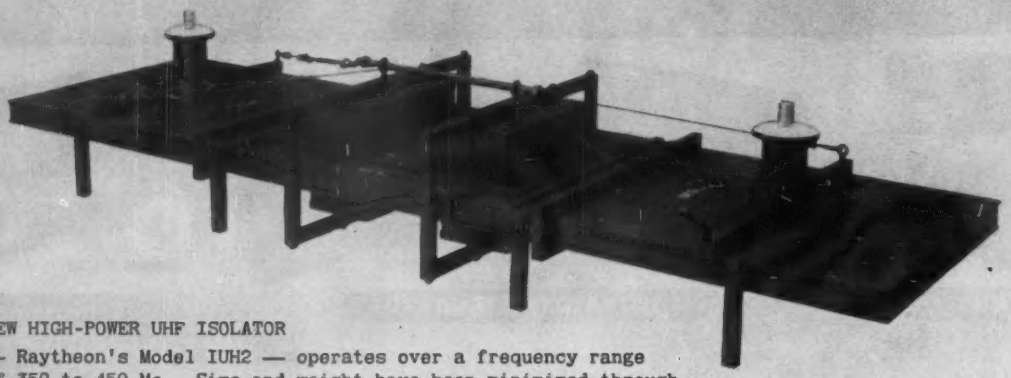


NEW HIGH-POWER UHF ISOLATOR
— Raytheon's Model IUH2 — operates over a frequency range of 350 to 450 Mc. Size and weight have been minimized through use of reduced-height waveguide. Dimensions, with transitions: 10 in. high, 27 in. wide, 90 in. long.

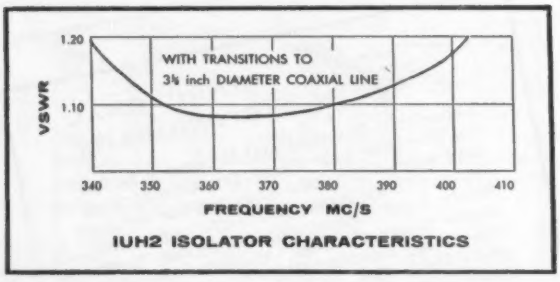
Microwave System Designers:

NEWEST RAYTHEON DEVELOPMENT EXTENDS HIGH-POWER ISOLATOR OPERATION DOWN TO 350 MC

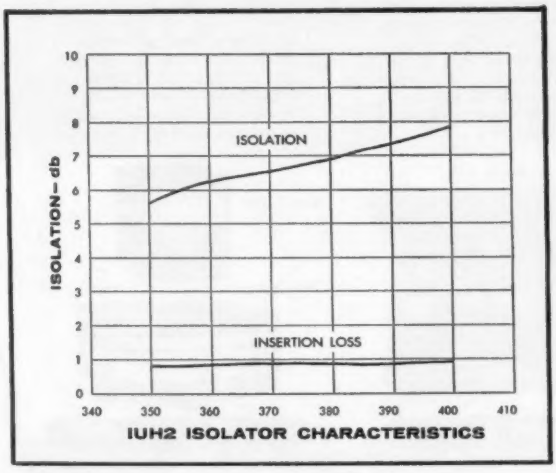
The first successful high-power UHF isolator commercially available has recently been developed at Raytheon.

The new unit brings greatly improved operating stability and extended life to UHF-power tubes. The isolator reduces or eliminates frequency pulling. The model IUH2 is capable of operation at average power levels exceeding 10 kilowatts. Peak power capacity is estimated at 10 megawatts.

Transitions can be supplied from the reduced-height waveguide to either full-height waveguide or coaxial line.



IUH2 ISOLATOR CHARACTERISTICS



IUH2 ISOLATOR CHARACTERISTICS

FOR FURTHER INFORMATION on this unit or other ferrite devices covering microwave frequencies, please write to the address below.

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CIRCLE 85 READERS SERVICE CARD

First Digital Voltmeter With Mathematically Perfect Logic . . .

The first stepping switch voltmeter with mathematically perfect logic . . . and the first to be completely transistorized! It's the NLS V-34, the latest instrument to be developed by the originators of the digital voltmeter. The exclusive new digital logic of the NLS V-34 allows readings to be made without cycling stepping switches through all nine positions in each decade. For the first time, "needless nines" are eliminated . . . the result: longer switch life and shorter measuring time. Check the exclusive features listed below.

"NO NEEDLESS NINES"

FOR FASTER MEASUREMENTS AND GREATEST RELIABILITY

MATHEMATICALLY PERFECT LOGIC — No numbers change that absolutely do not have to change. Stable measurements can be made of varying voltages.

STEPPING SWITCHES SEALED IN OIL — Each stepping switch is mounted in an individual oil-filled container. No manual lubrication needed. Oil bath extends life by factor of ten.

PLUG-IN STEPPING SWITCH MODULES — Stepping switches can be replaced as quickly as plugging in the meter.

FIRST COMPLETELY TRANSISTORIZED DIGITAL VOLTMETER — Even logic functions are performed by semi-conductors. Switch points reduced to one-half those required by "completely transistorized" competitive meters. Only the NLS V-34 is transistorized to the fullest possible extent.

SPECIFICATIONS

Range to ±1000 volts . . . Ratio to ±.9999 . . . 10 Megohm input impedance . . . 0.01% accuracy . . . Automatic range and polarity changing . . . five-digit model also available.

See the NLS V-34 at the 1959 I.R.E. Show . . . and write today for complete information.

Originators of the Digital Voltmeter

non-linear systems, inc. DEL MAR (San Diego), CALIFORNIA

1959 IRE SHOW — Booths 3041-2

COMPARISON CHART

The few steps required by the NLS V-34 to make a typical measurement (3rd column) are compared with the many required by competitive meters. Note the blue "needless nines" in the middle column.

NO. OF STEPS	COMPETITIVE METERS	NLS V-34
0	+.8888	+.8888
1	+.8889	−.8888
2	+.8880	−.9888
3	+.8890	−.0888
4	+.8800	−.1888
5	+.8900	−.1988
6	+.8000	−.1088
7	+.9000	−.1188
8	+.0000	−.1198
9	−.0000	−.1108
10	−.0001	−.1118
11	−.0002	−.1119
12	−.0003	−.1110
13	−.0004	−.1111
14	−.0005	
15	−.0006	
16	−.0007	
17	−.0008	
18	−.0009	
19	−.0019	
20	−.0029	
21	−.0039	
22	−.0049	
23	−.0059	
24	−.0069	
25	−.0079	
26	−.0089	
27	−.0099	
28	−.0199	
29	−.0299	
30	−.0399	
31	−.0499	
32	−.0599	
33	−.0699	
34	−.0799	
35	−.0899	
36	−.0999	
37	−.1999	
38	−.1099	
39	−.1199	
40	−.1109	
41	−.1119	
42	−.1110	
43	−.1111	

THE MEASUREMENT IS COMPLETED IN JUST 13 STEPS BY THE NLS V-34

NLS — The Digital Voltmeter That Works . . . And Works . . . And Works!

A Logical Deduction

Because The design of an NJE SOLID STATE transistorized power supply permits *no compromise with quality;*

Because every transformer and choke is a *MIL-T-27-A* style unit; every resistor is *wire-wound*; every capacitor is the *finest* of its type;

Because *every* component is significantly derated at the *worst combination* of line, load, and ambient conditions, including repeated short circuits and critical partial overloads;

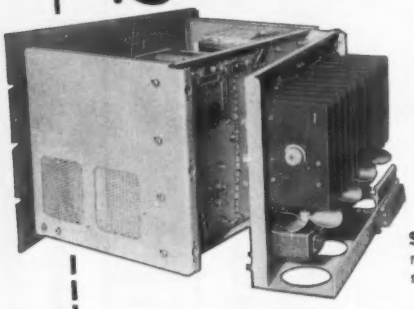
Because NJE "regulation" is the *total* of the *worst simultaneous combination* of line and load effects, static and dynamic;

Because NJE circuitry provides *stability*, against both time and temperature, *better than the rated regulation;*

Because we build all 14 standard models from three mass-produced "building blocks", *very competitively*, despite higher quality,

It follows that your best buy in a transistorized power supply is NJE SOLID STATE.

QED...choose NJE



SS-32-20,
rear view,
showing swing-out panel.

New Lower Prices,
Tighter Specifications!

Write for complete catalog

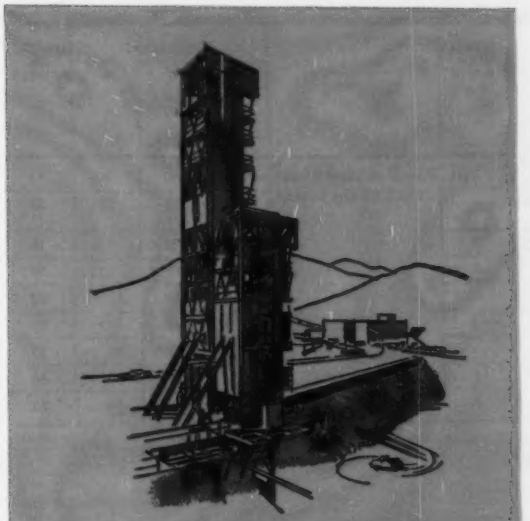
SS-10-10,
5¼" panel,
17½" deep.

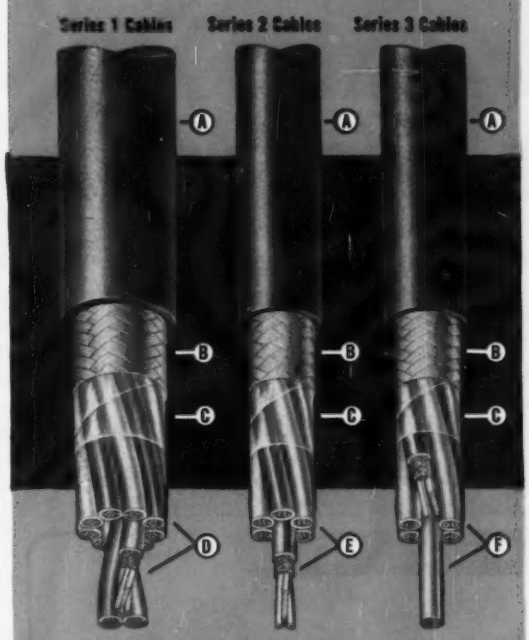
MODEL	VOLTS	AMPERES
SS-7-15	0-7	0-15
SS-10-10	0-10	0-10
SS-10-50	0-10	0-50
SS-18-2	0-18	0-2
SS-32-3	0-32	0-3
SS-32-10	0-32	0-10
SS-32-20	0-32	0-20

MODEL	VOLTS	AMPERES
SS-36-1	0-36	0-1
SS-1603	0-160	0-1.5
SS-1605	0-160	0-3.0
SS-3600	10-36	0-50
SS-1503	100-150	0-1.5
SS-3003	200-300	0-1.5
SS-1505	100-150	0-3.0

NJE CORPORATION
345 Carnegie Avenue, Kenilworth, New Jersey
CH 1-1500 TWX - ROSELLE, N.J. 51 FAX - FFP

WE CATALOG IN eem electronic engineers master





Ⓐ Vinyl jacket Ⓑ Tinned copper shield Ⓒ Mylar tape wrap Ⓓ 12 color coded groups. Each group: 2, 3, or 4 color coded conductors, shielded, jacketed Ⓔ color coded groups. Each group: 2, 3, or 4 color coded conductors, shielded, jacketed Ⓕ 6 color coded pairs cabled around vinyl filler. Each pair coded thermocouple wire, shielded, jacketed.

THE WILLIAM BRAND & CO., INCORPORATED

WILLIMANTIC 3 TURBO BRAND CONNECTICUT

electrical and electronic wires and cables • harnesses and cable assemblies • plastic and coated insulating tubings • identification markers

BRAND TEAMS WITH MARTIN TO MEET TOUGH CABLE SPECS FOR TITAN TEST FIRING

Absolute reliability! A must for the control and telemetering cables used for transmitting high fidelity signals during missile development static test firings. The data collected must be absolutely accurate if it is to establish the validity of the missile design or become the basis for necessary changes. The Martin Company found the solution to these tough signal transmission problems with three special multiconductor cables produced by Brand. Here's how Brand teamed with Martin to meet these new and difficult cable specifications:

Series 1 Instrumentation Cables: — Problem: Cables to have approximately the same uniform diameter with varying numbers of conductors, to fit into standard connectors. To meet critical electrical requirements, especially low loss characteristics. **Solution:** Use color coded Turbolene (polyethylene type) insulation to meet electrical and physical requirements. Give twisted pairs a uniform circular cross section by using specially developed **extruded** Turbolene fillers.

Series 2 Instrumentation Cables: — Problem: Cables to operate up to 100°C and to have approximately the same finished diameter with varying numbers of conductors. **Solution:** Use insulated wires meeting MIL-W-16878, manufactured with Turbo 540 vinyl compound and nylon jacketed. Carefully control lay lengths during cablings, and outer jacket wall thicknesses.

Series 3 Thermocouple Cables: — Problem: Non-hygroscopic, funginert cables, each six thermocouple pairs. **Solution:** Develop extrusion and cabling techniques to economically process hard and springy chromel, alumel, iron, constantan and copper conductors. Use Turbo 540 vinyl compound as primary insulation and as filler.

There were additional problems common to all series. (1) A vinyl jacketing material for the shielded groups to operate at both high and low temperatures, and to have an IR value comparable to those found in vinyl primary insulation. Turbo 570, a new custom formulation, was developed to meet these requirements. (2) All groups of conductors laid in a predetermined pattern to facilitate termination. The cables were manufactured on large two-bay planetary cablers to control positioning. (3) Long, unbroken, uniform lengths — all control and instrumentation circuitry is carried in steel reinforced concrete tunnels between test stands and blockhouse as shown in the above drawing.

Whether in missiles, aircraft, business machines or electronics — Turbo cables are custom engineered for specific operating conditions; manufactured by quality-conscious technicians; tested foot by foot for specification compliance. We invite you to call on our extensive engineering experience to solve your cable problems. No obligation, of course. Send your specifications or requirements.

Visit us at Booth M-19 at the IRE Show

MODEL NUMBER	OUTPUT		REGULATION				MAXIMUM RIPPLE IN MV	MOUNTING	DIMENSIONS			WEIGHT IN POUNDS
			LINE 105—125 V AC 50—60 CPS		NO LOAD TO FULL LOAD				H	W	D	
	Voltage	Current	%	V	%	V						
212A[1]	0—100 V DC	0—100 MA	0.15	0.05	0.1	0.05	½	MAY BE USED IN RACK OR ON TABLE.	3½	19	9¼	14
2-212A[1]	EQUIVALENT TO TWO MODEL 212A's. OUTPUTS MAY BE USED IN SERIES, PARALLEL, OR INDEPENDENTLY.								5¼	19	9¼	27
224A[1]	0—100 V DC	0—200 MA	0.15	0.05	0.1	0.05	1		3½	19	9¼	16
220A	0—50 V DC	0—500 MA	0.1	0.05	0.1	0.05	1		5¼	19	12½	30
221A	0—100 V DC	0—500 MA	0.1	0.05	0.1	0.05	1		5¼	19	12½	30
213A	0—50 V DC	0—1 AMP	0.1	0.05	0.1	0.05	1		7	19	11	35
214A	0—100 V DC	0—1 AMP	0.1	0.05	0.1	0.05	1		7	19	11	35
215A	0—50 V DC	0—3 AMP	0.1	0.05	0.1	0.05	1		10½	19	16	75
218A	0—100 V DC	0—3 AMP	0.1	0.05	0.1	0.05	1		10½	19	16	75

[1]Has Modulation Input.

Model 212AM $129 F.O.B. (meters extra)

*REGATRON TRANSISTOR POWER SUPPLIES

lowest ripple • widest useable range • super-regulated

©REGATRON

voltage regulation

The name ©Regatron on your power supply indicates that regulation is provided by a patented, super-regulating circuit. This circuit employs a balanced zero-potential comparator in an elementary bridge-like configuration. Together with a high-gain loop amplifier it provides increasing gain with decreasing voltage, with full loop gain available at zero output. The superior control and stability provided by this circuit results in a d-c power source that will give a degree of performance exceeding that of a battery.

Another Service of
ELECTRONIC MEASUREMENTS
COMPANY, INC.
©1959

IRE BOOTHS
2338-2340

The nine Regatron Transistor Power Supplies listed above are specially designed to furnish the ultra-smooth dc required for optimum transistor performance. They may be used at any voltage within their range . . . even at a fraction of one volt . . . with the assurance that rated current can be drawn without upsetting regulation or introducing ripple.

Ask your local representative for a demonstration. Better still, compare the performance of a Regatron against your present d-c power source, battery or otherwise. You'll be pleased to find a power supply that does what it says it will . . . besides, Regatrons like to be compared.

POWER FACT No. 4 **Transients:**

The transient performance of a power supply is assuming ever increasing importance. Yet there is lacking a standardized method for measurement, and no meaningful definition is agreed to by all.

For a discussion of this matter, including a suggested approach to a definition, write for Technical Bulletin No. 2004. It is free of charge.

*Registered U.S. Patent Office. U.S. Patents Issued and Pending.

ELECTRONIC MEASUREMENTS COMPANY, INCORPORATED

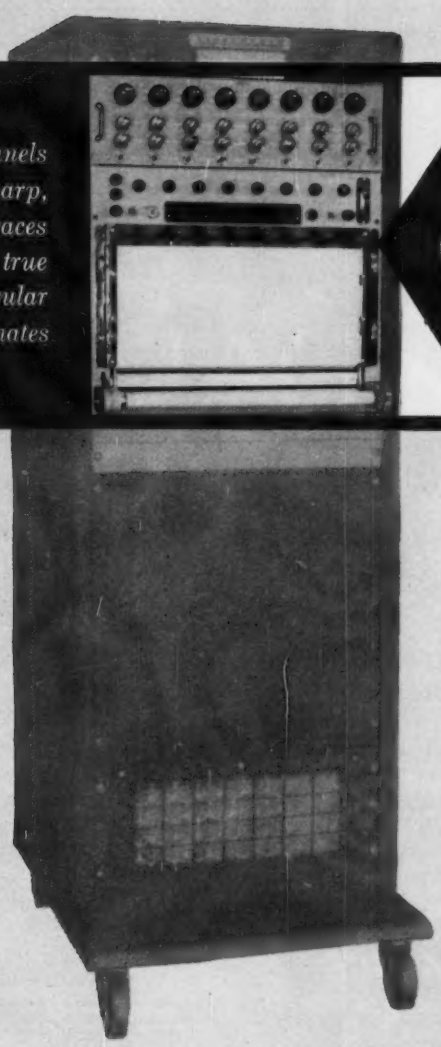
EATONTOWN • NEW JERSEY

CIRCLE 89 READERS SERVICE CARD CIRCLE 90 READERS SERVICE CARD→

ALL THIS

- **LINEARITY 0.5% OF FULL-SCALE**
- **COMPLETELY TRANSISTORIZED**
- **CURRENT FEEDBACK AMPLIFIERS**
- **VELOCITY FEEDBACK DAMPING**
- **GAIN STABILITY BETTER THAN 1%**
- **9 ELECTRICALLY CONTROLLED CHART SPEEDS**

6 or 8 channels of sharp, inkless traces in true rectangular coordinates



in a new, simplified...

5-VOLT FULL-SCALE SANBORN RECORDING SYSTEM

This new Sanborn direct writing system provides six or eight channels for computer readout, telemetry recording, DC voltage monitoring and similar applications where 0.1 volt/div sensitivity is sufficient and no preamplification is needed. The input impedance is 100,000 ohms. Frequency response is 3 db down at 100 cps at 10 div peak-to-peak amplitude; hysteresis is less than ±0.1 div. A 17½" Recorder-Amplifier-Power Supply package displays 8" of chart, locks in or out, loads easily from the front, has a built-in footage indicator and take-up, and can be completely remote-controlled. Galvanometers are rugged, low impedance, low voltage units with enclosed construction. The 5¼" Control Panel provides front and rear inputs, attenuator ratios of 1, 2, 5, 20 and 50, internal 2-volt calibration signals, position and smooth gain controls. The system is available in either the 60" mobile cabinet as shown (complete with power panel, wiring harness and built-in blower) — or as separate Recorder-Amplifier-Power Supply and Control Panel units for rack mounting.

Find out what this new system can do for *you*. Ask your local Sanborn Industrial Sales-Engineering Representative for complete facts — or write the Industrial Division in Waltham.

See this new System at the I.R.E. Show—Booths 3601-03-05

8-Channel Model 358-5480 Oscillographic Recording System . . . 6-Channel Model 356-5480 also available.

SANBORN COMPANY

175 Wyman Street, Waltham 54, Mass.

Engineers/Designers! Ask for this G-C

MICROWAVE FERRITE APPLICATION CHART

MICROWAVE FERRITE APPLICATION CHART

MATERIAL	BAND	LOWEST OPERATING FREQUENCY**	TYPICAL APPLICATION	TYPICAL POWER LEVEL
R-1	X	8,500 megacycles	Phase Shifter	Low Power
R-4	X	7,000 megacycles	Phase Shifter	Can be used above resonance at peak power > 1 Megawatt (2)
R-4	S	2,500 megacycles	Resonance Isolator (1)	Low Power
R-5*	C	5,000 megacycles	Phase Shifter	Can be used above or below resonance at peak power > 1 Megawatt (2)
R-5*	S	2,500 megacycles	Phase Shifter	Can be used above resonance at peak power > 1 Megawatt (2)
R-5*	L	1,000 megacycles	Resonance Isolator	Low Power
R-6*	S	2,500 megacycles	Phase Shifter	Similar to R-5
R-6*	L	1,000 megacycles	Resonance Isolator	Low Power

*NEW PRODUCT

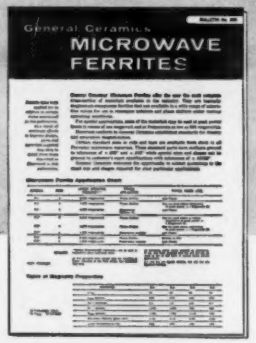
REMARKS:

(1) R-4 saturates more rapidly than R-1 resulting in faster reduction at low field losses. See hysteresis-loop data.

(2) Operating power levels reported by customers. It has also been reported that R-5 and R-6 can be used as low as 500 Mc/s in certain phase shifter applications.

R-1 and R-4 are Mg-Mn ferrites. R-5 and R-6 are Mg-Mn-Al ferrites.

**Lowest Recommended Frequency—can be used at frequencies above published value.



—it's included in the new General Ceramics Data Bulletin on Microwave Ferrites

This new comprehensive bulletin contains technical data on the most complete cross-section of materials in the industry, including two grades introduced for the first time. Included are hysteresis loops, magnetic and dielectric properties vs. frequency, and magnetic induction vs. temperature curves on ferrite materials R1, R4 and newly-developed R5 and R6. Application data, magnetic properties tables, and drawings and dimensions of available stock parts are also contained in new Bulletin 259. Request your copy of this informative literature, today; please address inquiries to General Ceramics Corporation, Keasbey, New Jersey—Dept. E.

See us at the RADIO ENGINEERING SHOW
BOOTHS 2221-2223
New York Coliseum
March 23rd to 26th

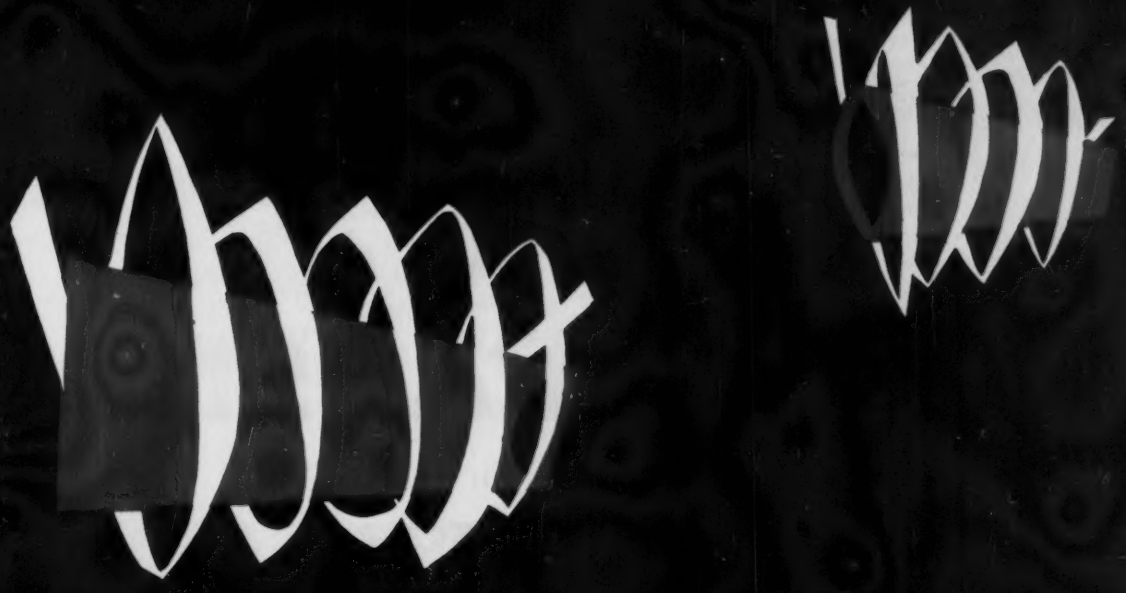
GENERAL CERAMICS
The World's Largest Producer of Microwave Ferrites

NEW OPPORTUNITIES FOR ENGINEERS
Positions are now open at all levels at General Ceramics—call or write for interview.

TV and Radio Cores | Magnetic Memory Cores | General Purpose Cores | Recording Head Cores | Microwave Ferrites

CIRCLE 91 READERS SERVICE CARD

CIRCLE 92 READERS SERVICE CARD→



MAXWELL MAGNETICS and MICROWAVE

Creative Imagination was for James Clerk Maxwell the catalyst that united a profound physical intuition and a formidable mathematical capacity in a brilliant formulization of electromagnetics—the basis of all today's practical electromagnetic applications.

At National Co. creative imagination is transmuting observed physical phenomena and mathematically formulated theory in such applications as long range microwave transmission—extending further our practical control of physical phenomena.

The implications of these new means of communications are manifold and the applications multitudinous.

National Co. is a community of minds and talents that enjoys the challenge and the prestige of success in such advanced fields as multipath transmission, noise reduction, correlation techniques for signal processing, Tropospheric scatter systems, Ionospheric scatter systems, molecular beam techniques, long range microwave transmission and missile check-out equipment using microwave and digital techniques.

At National Co. there is balance—an outstanding line of commercial receivers and components keeps National Co.'s business steady.

National Co. has grown with the Tradition of New England electronics. Your needs and problems receive exceptional attention at National Co., because, here, *creativity is required, recognized and rewarded.*

Write or phone

tuned to tomorrow **National** NC ®

National Company, Inc., Malden, Mass.

BURTON BROWNE ADVERTISING

PRESENTING A TRANSPARENT (No Amber Tint) SLEEVING FOR MIL-I-631C

Grades a and b Applications

Resinite EP-69C
VINYL INSULATION SLEEVING

Now — the many advantages of a transparent sleeving (without amber tint) are available in conformance to MIL-I-631C (Grades a and b, Class I and II, Cat. 1) and AMS-3630-B. New Resinite EP-69C permits easy identification of color-coded wires and full readability of printed coding. An all-purpose material, EP-69C surpasses all MIL-I-631C requirements and offers these valuable properties:

HIGH DIELECTRIC
900 volts/mil. (.016" wall. Other wall thicknesses proportionate).

FULL SIZE RANGE
#20 AWG through 2½" ID

NO TACKINESS
Slips easily over wires for harness assemblies.

WIDE TEMP. RANGE
–75°F to 185°F
(–60°C to 85°C)

FLAME RESISTANT

FUNGUS RESISTANT

5 COLORS
Transparent, black, white, red, blue.

CORROSION RESISTANT

SOFT-WOUND SPOOLING
Exclusive Resinite packaging delivers full-round, (not flattened) sleeving.

Whatever your insulation sleeving problem, there's an appropriate Resinite material. Call your Resinite distributor or write for samples and performance data.

®Resinite

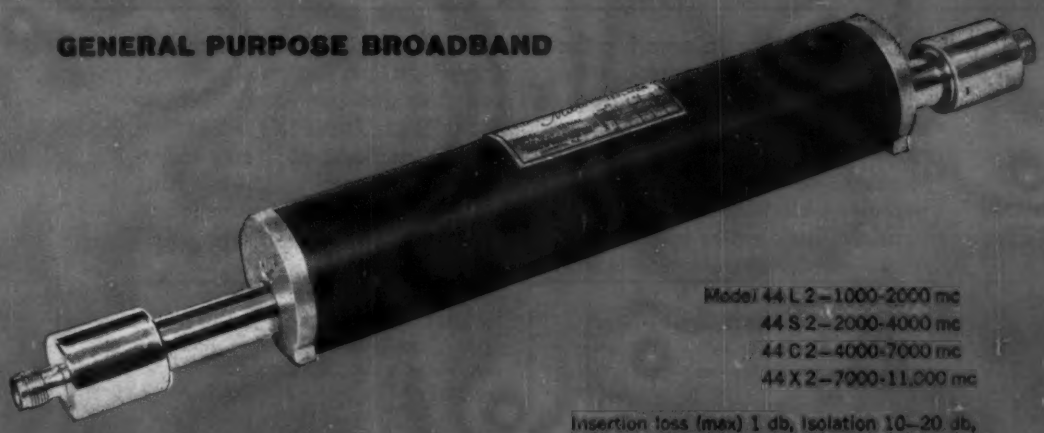
THE *Borden* CHEMICAL COMPANY Resinite Department
Plants: Santa Barbara, Calif. • No. Andover, Mass.

SPECIALISTS IN VINYL SLEEVING AND TUBING FOR THE AIRCRAFT, ELECTRONICS, ELECTRICAL AND PHARMACEUTICAL FIELDS

ALL AVAILABLE NOW

JUST 4 COAXIAL ISOLATORS COVER 1000 to 11,000 mc

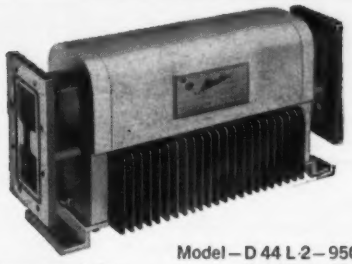
GENERAL PURPOSE BROADBAND



Model 44 L 2—1000-2000 mc
44 S 2—2000-4000 mc
44 C 2—4000-7000 mc
44 X 2—7000-11,000 mc

Insertion loss (max) 1 db, Isolation 10–20 db,
Power average 10 w, Peak 10 kw

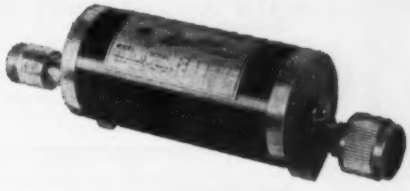
HIGH POWER VERSION FOR COUNTERMEASURES APPLICATIONS



Model—D 44 L 2—950-2350 mc
D 44 S 2—2000-4000 mc
D 44 S 22—2000-4000 mc
D 44 C 22—4000-7000 mc
D 44 X 22—7000-11,000 mc

Power average—400 w
Peak—10 kw
Insertion loss (max)—1.0 db
Isolation (min)—10 db

NARROW BAND— IMPROVED CHARACTERISTICS FOR RADAR



Model—44 L 1—1250-1350 mc
44 S 1—2700-3100 mc
44 C 1—5200-5900 mc

Insertion loss (max)—0.6 db
Isolation (min)—12 db
Power average—10 w

The isolators shown here are typical of the wide variety of new ferrite and solid state devices developed and manufactured by Sperry Microwave Electronics Company. All of these components represent the latest technical advances—all are the result of more than six years of intensive research devoted to this highly-specialized field.

For additional information, write to Sperry Microwave Electronics Company, Clearwater, Florida.

Visit our booth 1410-1416, 1959 Radio Engineering Show, March 23-26.

SPERRY

SPERRY MICROWAVE ELECTRONICS COMPANY, *CLEARWATER, FLORIDA • DIVISION OF SPERRY RAND CORPORATION*
***Address all inquiries to** Clearwater, Florida, or Sperry Gyroscope offices in New York • Cleveland • New Orleans • Los Angeles • San Francisco • Seattle*

Is your problem

Quality ?
Maintenance
Reliability
of electronic equipment

Here is your solution!

100% testing
—systems, circuits,
and components—
by Automation

CTI specializes in assuring the reliability of electronic and electrical equipment, whether components or complete systems. Automatic testing, for factory or for ground support, can accurately and completely diagnose electronic systems. Existing and incipient faults are found in far less time than by other quality control or maintenance methods. 90% cost reductions can be expected! Benefit from our extensive experience in adapting automatic methods to test problems, either with equipment designed to your requirements or with our standard equipments.

Tape-Programmed Circuit Tester
Tests electronic and electrical circuits and systems according to values punched in tape. *Model 180*

Automatic Circuit Tester
Voltages, impedances, resistances, etc. of complex circuits and equipment are checked on a go/no-go basis. *Model 100*

Automatic Circuit Tester
Designed especially for rack-mounted test installations, this is another in the series of CTI Supertesters shown above. *Model 104*

Component Tester
Insertion of a punched card instantly programs test series and test limits for any one of the seven basic electronic components. *Model 176*

Cable Tester
Simultaneously measures continuity, leakage, and d-c hi-pot on complex cable harnesses. The latest state of the art in cable testing. *Model 165*

Missile Test Console
Continuously monitors circuits of main missile wiring harness undergoing 15-minute vibration test. *Custom made*

Missile Check Out
Performs final electrical test on missile guidance head. *Custom made*

Missile Hi-Pot Test Station
Hi-pots main forward and aft missile wiring harnesses. *Custom made*

Tape Reader
For programming automatic equipment, this reader provides 80 bits of information at each advance of the punched tape. *Model 171*

Tape Punch and Tape Duplicator
Facilitates tape programming, and, used with above reader, reproduces and speeds editing of tapes. *Models 173 and 174*

CALIFORNIA TECHNICAL INDUSTRIES

DIVISION OF TEXTRON INC.
BELMONT 7, CALIFORNIA
Foremost in Automatic Testing

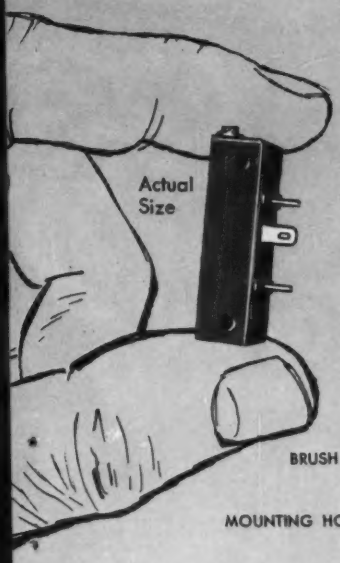
CTI®

See this equipment at the New York IRE SHOW Booths 1111-1112

Engineers: Career opportunities are currently available at CTI

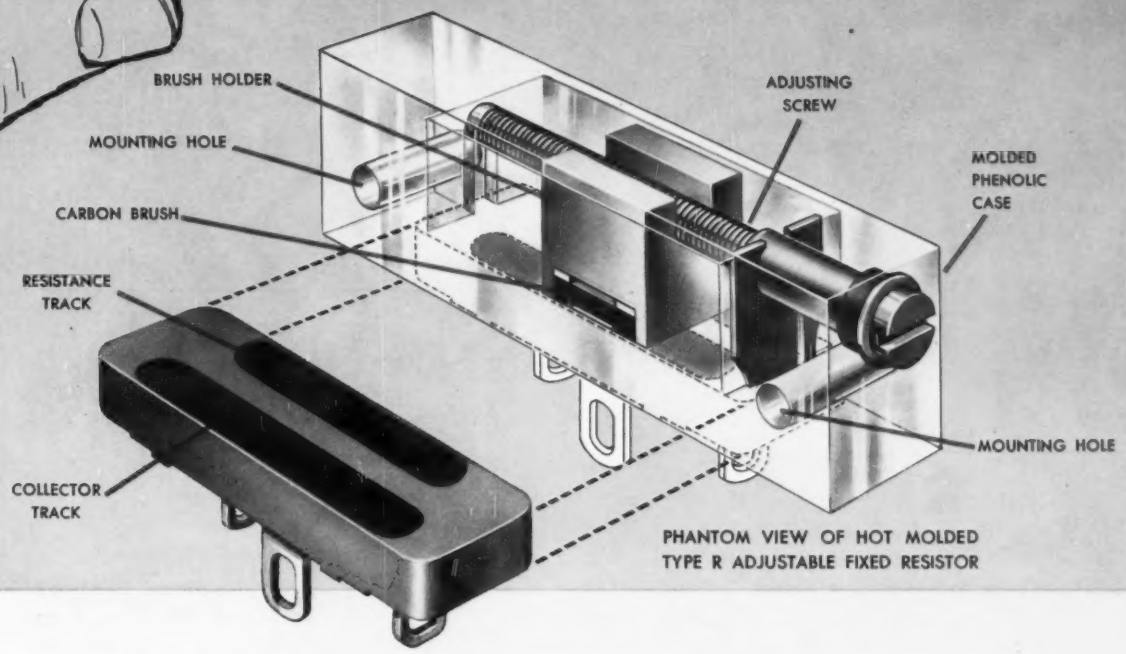
CIRCLE 95 READERS SERVICE CARD

CIRCLE 96 READERS SERVICE CARD→



NEW ALLEN-BRADLEY

Adjustable Fixed Resistor



PHANTOM VIEW OF HOT MOLDED TYPE R ADJUSTABLE FIXED RESISTOR

Exclusive hot molded dual track resistance element and carbon brush give unmatched reliability and long life

SPECIFICATIONS

Power Rating: ¼ watt at 70°C ambient

Voltage Rating: 350 volts maximum

Temperature Range: −55°C to 120°C

Resistance Range: total resistance values from 100 ohms to 2.5 megohms ±10% or ±20%

Adjustment: approximately 25 turns

Dimensions: approximately 1¼" x 21/64" x ¼"

Terminals: lug and pin type terminals on 0.1" grid system and are gold plated for ease of soldering.

Here's a new, compact, adjustable fixed resistor—the Type R—with Allen-Bradley's exclusive hot molded resistance element. It's the same type resistance element used in the popular Type J and Type G units . . . which have proved unequaled for reliability and long life. Operation is exceptionally smooth—no abrupt resistance changes occur with adjustment. The molded case of the Type R adjustable fixed resistor is watertight and dust-tight. The mounting for the moving element is self-locking to assure stable setting—and the entire unit can be "potted" after adjusting. The adjustment screw has a "free wheeling" clutch to prevent damage.

Send for complete information on this latest addition to the Allen-Bradley line of *quality* potentiometers.

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

A-B QUALITY

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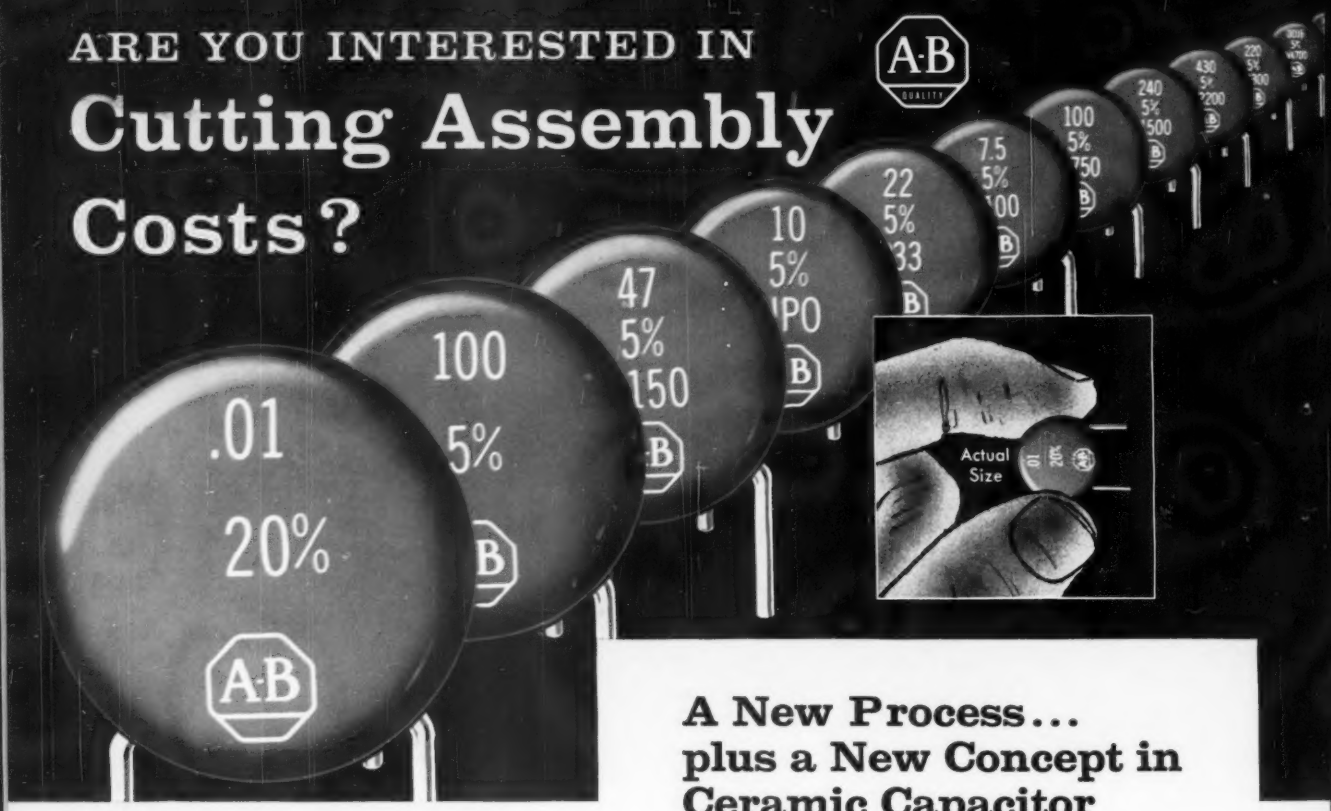
QUALITY

ELECTRONIC COMPONENTS

2-59-R

ARE YOU INTERESTED IN

Cutting Assembly Costs?

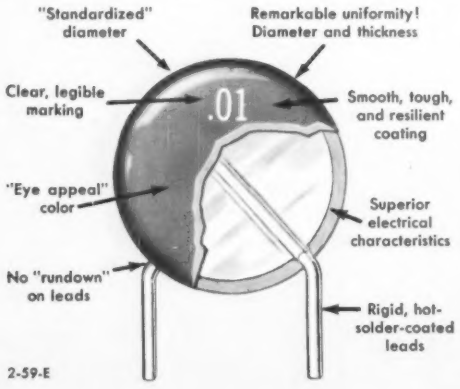


New "Auto-Coat process" makes high speed machine assembly possible—but it also makes manual assembly quicker—at lower cost!

Allen-Bradley's new "Auto-Coat process" provides a tough, smooth insulating coating of uniform thickness—it does not use wax or other sticky impregnants which are bound to clog automatic machines. The physical uniformity of these capacitors permits accurate mechanical or manual insertion on printed boards.

With "rundown" on leads eliminated, the capacitor is permitted to rest directly on printed boards—for solid, three-point mounting. Costly cleaning or crimping of wires to prevent soldering failures is a nightmare of the past; lead inductance is less.

Allen-Bradley Type A Ceramic Capacitor



2-59-E

A New Process... plus a New Concept in Ceramic Capacitor Standardization!

... provides superlative electrical properties

Standardization on only *one size* of capacitor—0.55″ diam—for most values, permits scientific selection of ceramic materials with the *optimum* dielectric constant for *each* capacitance value. Through such advanced design technique, Allen-Bradley Type A ceramic capacitors provide greater dielectric strength and greater breakdown voltage . . . creepage paths are also increased. In addition, the coefficients of temperature, frequency, and voltage are lower . . . and the power factor is lower, too.

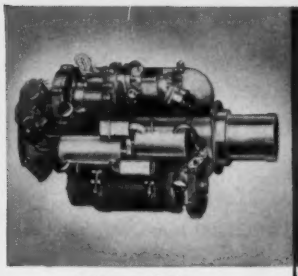
Allen-Bradley's standardizing on *one size* for all capacitance values has produced a *superior* capacitor that can be assembled by machines on printed boards at lower cost. Manual assembly costs are reduced, and capacitor inventory costs are also reduced.

Allen-Bradley Type A capacitors are available in general purpose, stable, and temperature compensating types in the most frequently used values. Send for new data sheets.

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY
ELECTRONIC COMPONENTS
QUALITY

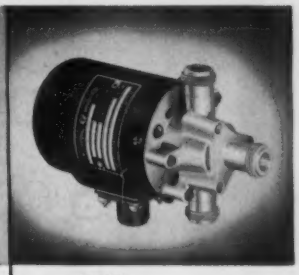
fourth in a series THE DIVISIONS OF THOMPSON RAMO WOOLDRIDGE INC.



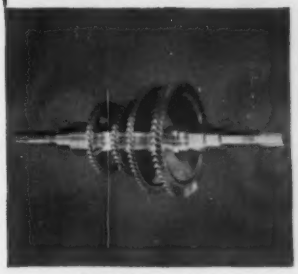
Solid-propellant auxiliary power unit

Titanium missile pressure vessel

Combination main and after-burner fuel pump



Coaxial switch



Four-stage turbine wheel

100 MILLION JET ENGINE BLADES
1.1 MILLION AIRCRAFT AND MISSILE FUEL PUMPS
APU'S FOR 6 DIFFERENT MISSILES

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These are some of the products of the TAPCO Group of Thompson Ramo Wooldridge Inc. With $150,000,000 of high-efficiency production facilities, TAPCO is one of the nation's leaders in the development and manufacture of mechanical systems, equipment, and components that must meet stringent performance specifications under extreme conditions of temperature, corrosion, and stress.

Through its metallurgical and chemical laboratories, TAPCO continually extends its capabilities in the technology of high-temperature alloys, powder metallurgy, cermets, ceramics, and other materials. TAPCO was one of the principal pioneers in the fabrication of titanium, and is currently engaged, in cooperation with E. I. du Pont de Nemours & Co., in the development of manufacturing techniques to handle niobium and its alloys.

In product design and development, TAPCO's 500-man engineering team is experienced in a wide range of specialties, including hydraulics, aerodynamics, electronics, pneumatics, thermodynamics, and nucleonics.

Aircraft and missile technology increasingly demands mechanical systems, equipment, and components that can meet uncommon requirements of precision, strength, and reliability under the most severe environmental conditions. The combination of engineering, metallurgical and manufacturing competence represented in the $160,000,000 per year activities of the TAPCO Group provides an integrated capability of unusual effectiveness for the design and manufacture of such products.

100,000 rpm turbine-driven alternator

Missile gyro ground test unit

Jet engine case assembly

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who are attending the

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March 23-26

and who can contribute importantly to our advanced electronic programs are invited to contact the Litton Industries Representative, Mr. C. T. Petrie, at the Convention hotel. Phone PLaza 5-4225

One of several satisfactions at Litton Industries Electronic Equipments Division is the experience of participating in research that moves through development and engineering to completed production. Work now in progress includes advanced complete systems for military, industrial and commercial applications; while computer techniques are being projected to the spectrum of 1970.

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DESIGN

RADAR AND COUNTERMEASURES:

ANALYSIS
DESIGN

TACTICAL DATA PROCESSING SYSTEMS:

ELECTRONIC PACKAGING
DIGITAL SYSTEMS
LOGICAL DESIGN
VIDEO CIRCUITS
SYSTEMS ANALYSIS

COMPUTER CONTROLS AND SYSTEMS:

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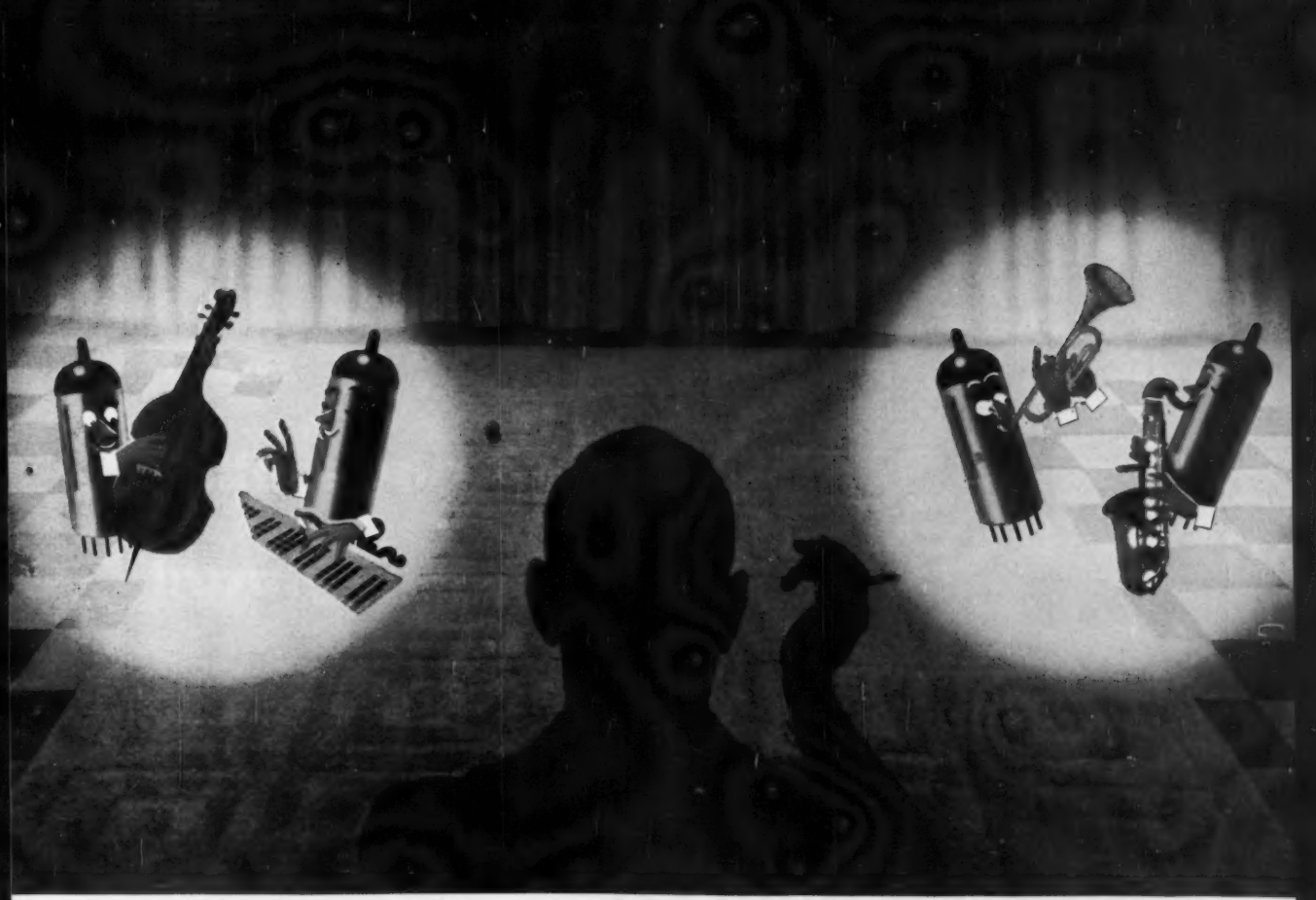

Amperex® *tubes are making music in the world's finest* ~~STEREO~~ *systems...*

AMPEREX 'preferred' tube types have proven themselves in the world's finest *monophonic* amplifiers. Now AMPEREX is paving the way with tubes for the world's finest *Stereophonic systems.* Developed in the research laboratories of Philips of the Netherlands, and applications-engineered by Amperex for the American electronics industry, these ultra-advanced tubes have proven their reliability and unique design advantages in late model amplifiers and tuners of the world's leading high fidelity manufacturers. Sold by franchised dealers everywhere... available for off-the-shelf deliveries in any quantity.

Detailed data and applications engineering assistance available from Semiconductor and Special Purpose Tube Division, Amperex Electronic Corp., 230 Duffy Avenue, Hicksville, Long Island, N. Y.

ask **Amperex**

about hi-fi tubes for hi-fi stereo circuitry

POWER AMPLIFIER TYPES

6CA7/EL34—Exceptionally linear, high-power output pentode with low-voltage drive requirements. Up to 100 watts in push-pull.

EL84/6BQ5—Unique AF power pentode combining high gain and linearity with 9-pin miniature construction. Up to 17 watts in push-pull.

EL86/6CW5—Low voltage, high current version of the type EL84/6BQ5. Up to 20 watts in push-pull.

ECL82/6BM8—Triode-pentode. Up to 8 watts in push-pull.

UCL82/50BM8—Series string (100 ma. 50v) version of ECL82/6BM8.

PCL82/16A8—Series string (300 ma. 16v) version of ECL82/6BM8.

VOLTAGE AMPLIFIER TYPES

EF86/6267—High-gain pentode with exceptionally low hum, noise and microphonics.* Particularly suitable for pre-amplifier and input stages. Similar to the Z739 and the 5879.

ECC81/12AT7—Medium-gain dual triode with low hum, noise and microphonics. Replaces the 12AT7 without circuit changes.

ECC82/12AU7—Low-gain dual triode with low hum, noise and microphonics. Replaces the 12AU7 without circuit changes.

ECC83/12AX7—High-gain dual triode with low hum, noise and microphonics. Replaces the 12AX7 without circuit changes.

ECF80/6BL8—High-gain triode-pentode with low hum, noise and microphonics.

RF AMPLIFIER TYPES

6BJ8/ECC88—Frame grid, sharp cut-off twin triode. Particularly suitable for cascode circuits, RF & IF amplifiers, mixer & phase inverter stages. Features high transconductance and low noise.

***6ES8**—Similar to 6DJ8/ECC88. Has remote cut-off characteristics.

***6ER5**—Frame grid shielded triode with remote cut-off characteristics. Suitable for RF amplifiers in TV & FM tuners. Features high transconductance and low noise.

†**ECC85/6AQ8**—High gain dual triode for FM tuners with shield between sections for reducing oscillator radiation.

EBF89/6DC8—Duo diode-pentode with remote cut-off characteristics. Suitable for RF & IF amplifiers.

ECF80/6BL8—High gain triode-pentode for RF amplifiers.

RECTIFIER TYPES

EZ80/6V4—Indirectly heated, full-wave rectifier with 6.3 v, 0.6 amp. heater, 90 ma. output capacity and 9-pin miniature construction.

EZ81/6AC4—Indirectly heated, full-wave rectifier with 6.3 v, 1 amp heater, 150 ma. output capacity and 9-pin miniature construction.

GZ34/5AR4—Indirectly heated, full-wave rectifier with 5 v, 1.9 amp heater and 250 ma. output capacity. Octal base. Replaces the 5U4G without circuit changes with the advantage of lower tube voltage drop because of the unipotential cathode.

Also Available: INDICATOR TUBE TYPES

EM84/6FG6—Indicating pattern is a varying length bar. For use in broadcast receivers and tape recorders.

DM70/1M3—Subminiature type with "exclamation mark" indicating pattern. Features low filament consumption (25 ma.).

GERMANIUM DIODES

1N542—Matched pair. Replaces 6AL5 in FM detector circuits.

1N87A—High RF rectification efficiency diode. Suitable for AM detector circuits.

*300, 450 & 600 ma series string versions available.
†300, 150 & 100 ma series string versions available.

CAN SYNCHROS BE MOISTURE-PROOFED?

Thanks to the special materials and construction of improved Ketay synchros, the moisture-resistance standards of Mil Spec 20708 (superseding all previous specifications) can be met *or exceeded.*

Many of these special materials and design features are exclusive with Ketay . . . the only source currently manufacturing and shipping a wide range of the new Mil-type synchros.

Stainless steel housing, shafts, and bearings . . . stators potted in anti-fungus epoxy resin . . . hermetically sealed windings . . . thru-bore construction for fewer parts and less space where moisture can collect . . . these and a variety of other Ketay features all give extra protection against moisture damage.

For high performance and dependability, despite extremes of humidity and temperature, specify Ketay synchros and other precision components, available in production quantities in sizes from 8 to 23. Sixty cycles per second units are available as small as size 15. Units one or more sizes smaller and lighter than previously required can often be used, because of Ketay's superior accuracy. Units of 3′ and 2′ accuracy are available for immediate delivery.

Ketay engineers are working with manufacturers whose prototype systems have unusual environmental and accuracy requirements. Call or write for help in solving your special problems.

Ketay precision components:
SYNCHROS
RESOLVERS
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NORDEN Division of United Aircraft Corporation

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Wide Bandwidth with True Differential Input

Only Epsco Instrumentation Amplifiers give you all these features...

- **WIDE BANDWIDTH** . . . dc to 150 kc at gain of 100
- **TRUE DIFFERENTIAL INPUT** . . . true balance, low capacity
- **HIGH COMMON MODE REJECTION** . . . 200,000 to 1 dc . . . 50,000 to 1 ac
- **HIGH GAIN** . . . selectable gains of 100, 200, 500, 1000, 2000
- **HIGH STABILITY** . . . drift less than 2 μv per day; less than 5 μv long term cumulative drift
- **LOW NOISE** . . . less than 3 μv rms to 50 cps
- **HIGH POWER OUTPUT** . . . $\pm$20 volts, up to 40 ma
- **100,000 OHM INPUT IMPEDANCE**
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- **WIDE DYNAMIC RANGE** . . . unsaturating at twice nominal output
- **NO ADJUSTMENTS OR CALIBRATIONS**
- **NO BATTERIES**

With the ever-increasing need for greater accuracy in dynamic instrumentation the demand for an expanding bandwidth in signal amplification becomes more and more urgent. Epsco Instrumentation Amplifiers not only meet the bandwidth challenge, but they also provide true differential input.

Available rack-mounted or in portable units. Write for Bulletin 105801 for complete technical information and options available.

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Design better products with

SILASTIC RTV cures at room temperature

SILICONE RUBBER

. . . protects against moisture and shock

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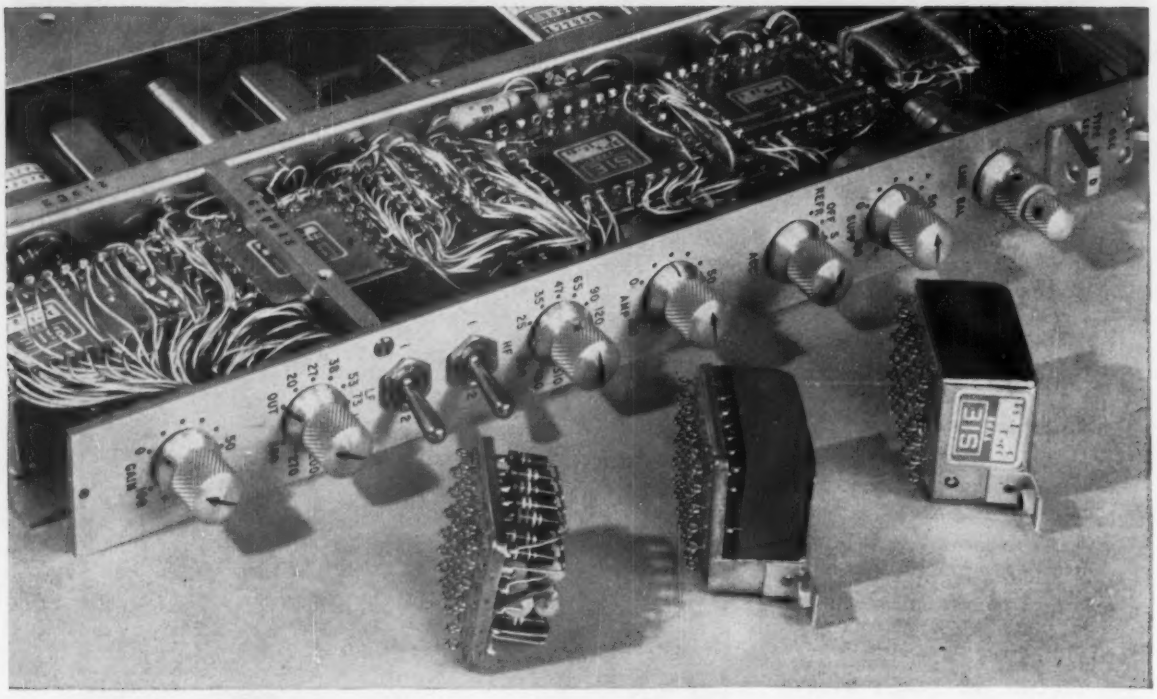


Potted with Silastic RTV, a component can (center) is ready for use in Southwestern Industrial Electronics' geophysical amplifier. Silastic RTV protects and seals circuits against many hazards.

Protect and seal sensitive electronic instruments this new, "do-it-yourself" way. Silastic® RTV, the Dow Corning silicone rubber, vulcanizes at room temperature to form a rubbery silicone solid overnight. Simply apply with calking gun or by hand — no processing required. Parts made with Silastic RTV withstand temperatures from —70 to 250 C, resist moisture and oxidation, cushion vibration and shock. Dielectric properties are excellent. Use Silastic RTV for encapsulating, potting or calking. Free literature available.

If you consider ALL the properties of a silicone rubber, you'll specify SILASTIC.

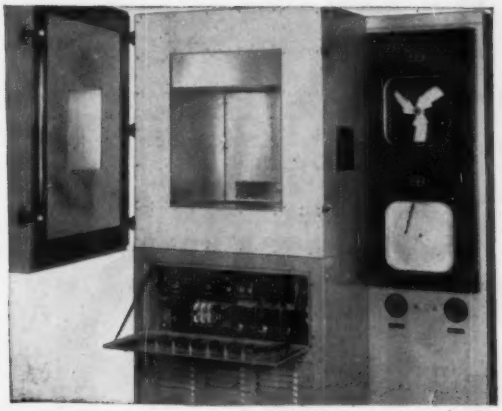
TYPICAL PROPERTIES OF SILASTIC RTV

Temperature range	—100 to 480F
	—70 to 250C
Dielectric strength, volts/mil	300 to 500
Surface resistivity at 50% Relative humidity, ohms	2.8×10^{13}
Dielectric constant, 10^5 cycles per second	2.5
Dissipation factor, 10^5 cycles per second	0.003

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

Dow Corning Silicone Dielectrics



Trop-Arctic temperature-test chamber

SILICONE-GLASS LAMINATES SURVIVE DEEP FREEZE, OVEN HEAT

Virtually unaffected by temperatures as high as 250 C, silicone-glass laminates are ideal insulating and structural materials. They are lightweight, strong, moisture and arc resistant . . . have low loss factor, low moisture absorption. Can be drilled, machined, sanded, sawed. Supplied in various finished shapes by leading laminators.

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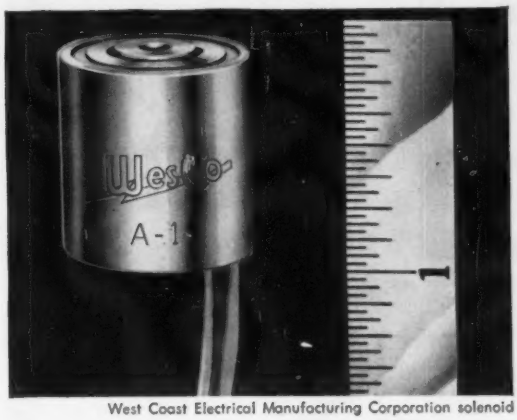

West Coast Electrical Manufacturing Corporation solenoid

SYLKYD ENAMELED WIRE AIDS MINIATURIZATION

Heat-stable Sylkyd® enameled magnet wire makes it possible to design smaller and more reliable electronic equipment. Equal in diameter to Class A wire, Sylkyd enameled wire is suitable for use in 180 C insulation systems; resists moisture, corona, most chemicals; has good shelf life and handling properties. Write for new illustrated brochure.

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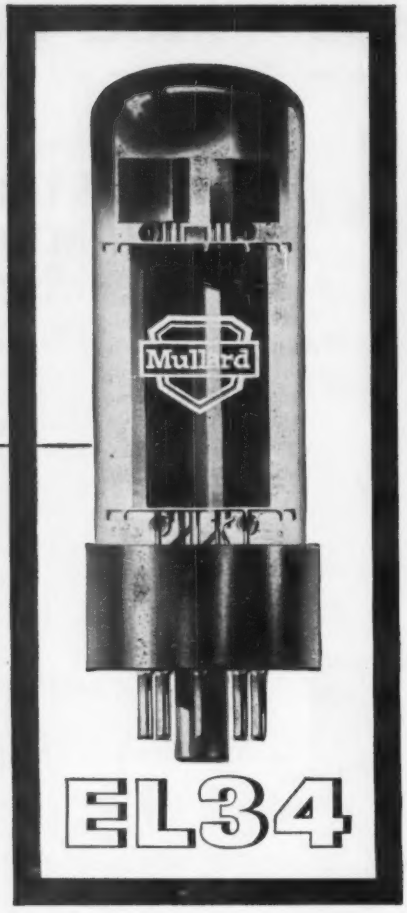
American Machine and Manufacturing Co. miniature coils

For further information on these products, write Dept. 489

ELECTRONICS
IN
BRITAIN



This is BRITAIN'S LEADING 25W OUTPUT PENTODE

and here are the reasons why

✻ 34W of high fidelity stereo output per channel from two tubes in ultralinear push-pull

✻ very high slope of 11,000 ohms resulting in high sensitivity with low drive requirements

✻ modern construction—an all-glass bulb with a pressed glass foot on an octal base

✻ may be operated at high anode voltage

Other Mullard Hi Fi audio tubes

EF86 6267	AF input pentode with exceptionally good microphony and high gain.
ECC83 12AX7	Double triode, low hum, low microphony, low noise, high gain input tube.
EZ81 6CA4	Miniature full wave cathode type rectifier with high voltage and with good regulation supplying up to 150mA.
GZ34 5A34	Bantal full wave cathode type rectifier, supplying high voltage with good regulation and with currents up to 250mA.
ECL82 6BM8	Miniature triode pentode for use as audio amplifier and output tube. Two tubes in ultralinear push-pull can supply up to 7 watts of stereo power per channel.
EL84 6BQ5	Miniature 12 watt high slope pentode. A medium power high fidelity tube particularly suitable for compact stereo circuits. up to 17 watts per channel.

Abridged Data

Heater		
V_h	... ...	6.3V
I_h	... ...	1.5A
Characteristics		
V_a	... ...	250 V
V_{g2}	... ...	250 V
V_{g3}	... ...	0 V
I_a	... ...	100 mA
I_{g2}	... ...	15.9mA
V_{g1}	... ...	—12.2V
g_m	... ...	11 mA/V
r_a	... ...	15 kΩ
μ_{g1-g2}	... ...	11

Typical performance details for this tube are given here—for further information and supplies write to one of the distributors listed

Supplies available from:
In the U.S.A.

International Electronics Corporation,
Dept. E3, 81 Spring Street, N. Y. 12.
New York, U.S.A. Worth 6-0790

In Canada

Rogerts Electronic Tubes & Components,
Dept. 10, 116 Vanderhoof Avenue,
Toronto 17, Ontario, Canada.
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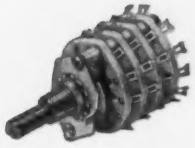
MEV85

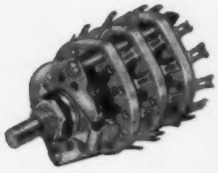
Solving switch problems fast . . .

your job . . . and Centralab's

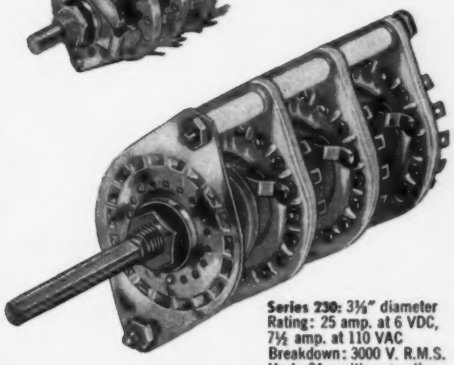
Series 100: 15/16" diameter
Rating: 0.5 amp. at 6 VDC, 100 ma at 110 VAC
Breakdown: 750 V. R.M.S.
Up to 12 positions/section



Series 20: 1 5/16" diameter
Rating: 2 amp. at 15 VDC, 150 ma at 110 VAC
Breakdown: 1500 V. R.M.S.
Up to 12 positions/section



Series 275: 1 3/8" diameter
Rating: 2 amp. at 15 VDC, 150 ma at 110 VAC
Breakdown: 1500 V. R.M.S.
Up to 23 positions/section



Series 230: 3 1/8" diameter
Rating: 25 amp. at 6 VDC, 7 1/2 amp. at 110 VAC
Breakdown: 3000 V. R.M.S.
Up to 24 positions/section

Your switch problems can be solved quickly and efficiently at CENTRALAB. No matter how unusual or difficult the switch, you can get samples fast, quotations fast, and production fast! This is a result of years of specialized experience and superior facilities for designing and manufacturing a wide variety of switch types.

Typical of the extensive range of units available to you are the four CENTRALAB ceramic section switches shown here. These switches, and many others, are also available with phenolic sections, for economy applications, or where a larger number of positions is required.

DESIGN AIDS FOR ENGINEERS

CENTRALAB'S unique Switch Visualizer, which simulates actual switch operation, will help you simplify and speed up switch design. Used in conjunction with our detailed layout sheets (available for all CENTRALAB switch types), they greatly facilitate your job in switch design (and ours, too). Write for them today—along with a copy of CENTRALAB Switch Catalog 42-405.

Centralab
P-5917

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VARIABLE RESISTORS • ELECTRONIC SWITCHES • PACKAGED ELECTRONIC CIRCUITS • CERAMIC CAPACITORS • ENGINEERED CERAMICS

AEROCOM'S 1046 H.F. TRANSMITTER

POWER + STABILITY

1000 WATTS WITH .003% STABILITY

Rugged, versatile general purpose H.F. transmitter—Aerocom's 1046 packs 1000 watts of power and high .003% stability under normal operating conditions (0° to +50°C.). Excellent for point-to-point or ground-to-air communications.

Multi-channel operation on telegraph A1, or telephone A3 with GM-8A modulator... new Aerocom 1046 can be *remotely controlled* with TMC-R at control position and uses only one pair of telephone lines. In A3 operation, the local dial control panel is located in modulator cabinet.

Transmitter cabinet has 8¾ inch panel space available for either local dial control panel or frequency shift keyer.

Model 1046 operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.0—24 Mcs. Operates on one frequency at a time; channeling time 2 seconds. Operates into either balanced or unbalanced loads. Operates in ambient -35° to+50° C. Power supply: nominal 220 volts, 50-60 cycles, single phase.

Complete technical data on request

1046 transmitter GM-8A modulator

Now! Complete-package, 192 channel, H.F., 75 pound airborne communications equipment by Aer-O-Com! Write us today for details!

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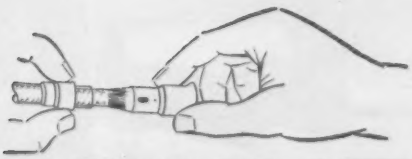

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- Further, coaxial cable is fully supported against vibration.
- All this in seconds . . . no more burned insulation . . . no more tedious soldering . . . no more doubtful connections. Attachments at unbeatable speed that give you the finest termination at the lowest total installed cost.

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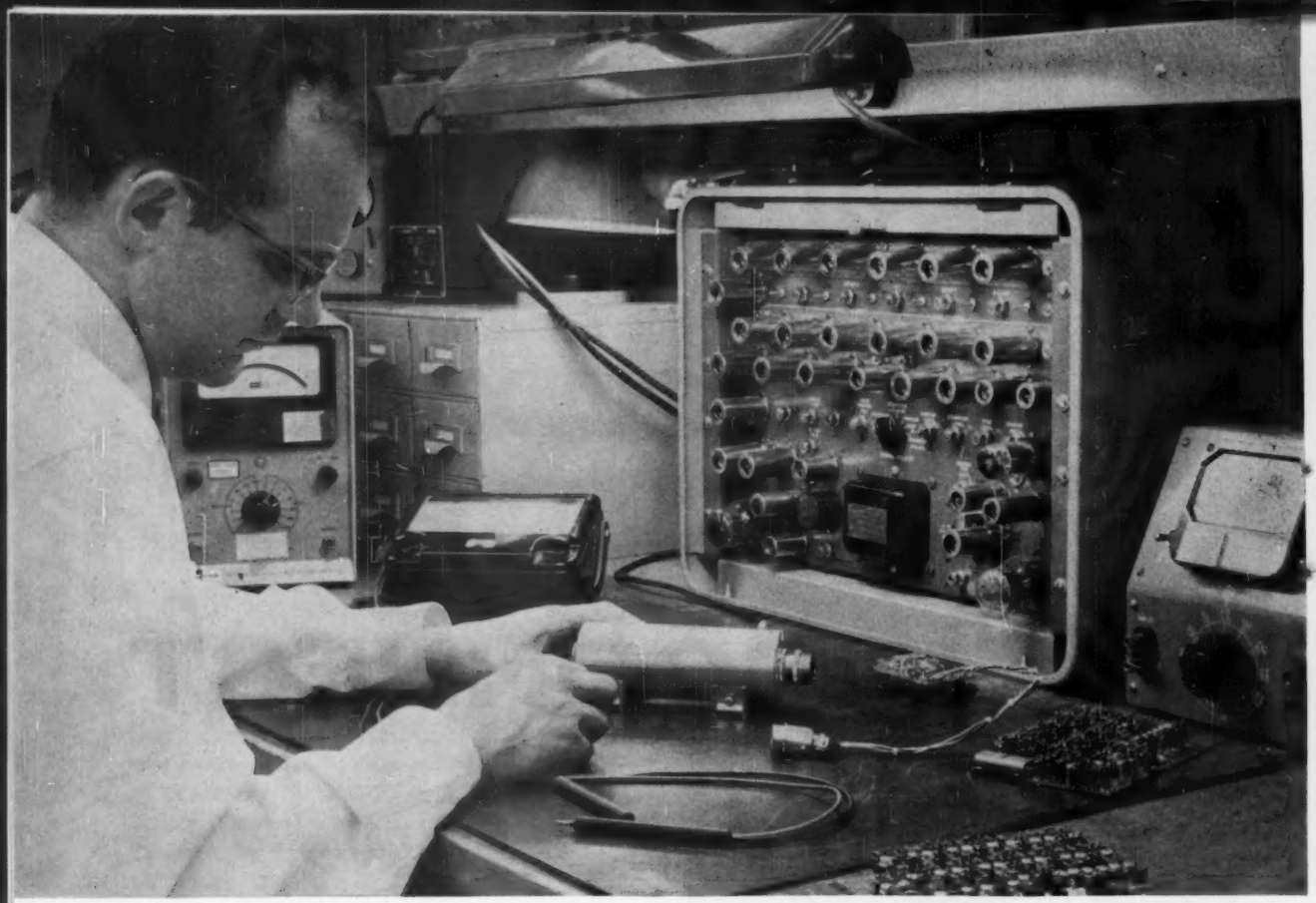
A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan



ELECTRONICS / EXPANDING THE FRONTIERS

Significant contributions to the advancement of the state of the art in electronics have been made by Lockheed engineers and scientists. As manager of important missile and weapon systems, the Division has solved a variety of problems in the electronics field. These include: computer development; telemetry; radar and data link; transducers and instrumentation; microwave devices; antennas and electromagnetic propagation and radiation; ferrite and MASER research; solid state electronics, including devices, electro-chemistry, infrared and optics; and data reduction and analysis.

Over one-fifth of the nation's missile-borne telemetering equipment was produced by Lockheed last year. Its PAM/FM miniaturized system provides increased efficiency at one-fourth the weight of FM/FM missile-borne systems.

Advanced development work in high-energy batteries and fuel cells has resulted in a method for converting chemical energy directly into electrical power that promises a fuel utilization of almost 100% and an energy conversion efficiency of 70% or better.

Areas of special capability in computer development include the design of large scale data handling systems; development of special purpose digital computing and analog-digital conversion devices; development of high speed input-output equipment; and advanced research in computer technology, pattern recognition, self-organizing machines, and information retrieval.

Other major developments are: a digital flight data recorder able to record each of 24 channels every few seconds; digital telemetry conversion equipment to reduce telemetered test data to plotted form rapidly and inexpensively; advancements in the theory of sequential machines; and a high speed digital plotter that can handle some four thousand points per second with the finished plot programmed into the data tape as a continuous curve.

Lockheed Missiles and Space Division is engaged in all fields of the art—from concept to operation. Its programs reach far into the future and deal with unknown environments. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics"—NATIONAL MISSILE INDUSTRY CONFERENCE AWARD.

Lockheed / MISSILES AND SPACE DIVISION

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO

(top left) 6" miniaturized TV camera, a Lockheed first in both the missile and television fields.

(top right) Automatic Checkout and Readiness Equipment ("ACRE") system developed by Lockheed combines outstanding performance at lowest cost in the industry. It includes internal, stored programs; magnetic drum memory and internal self-verification and has wide commercial application as well as for weapons systems.

I.R.E.

NATIONAL CONVENTION

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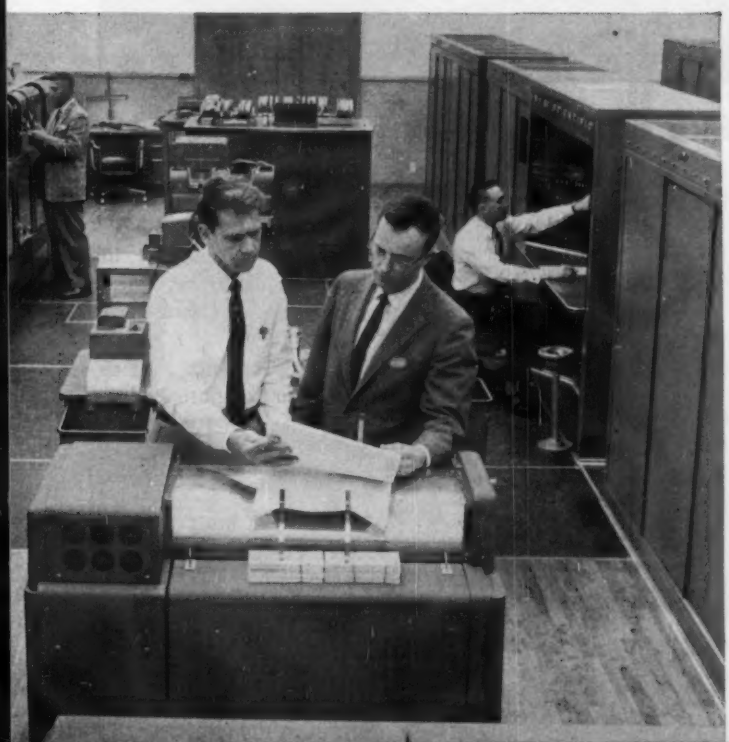
New York • March 23-26

Electronics research and development represents one of Lockheed's most intensive activities. Listed below are unusual opportunities that exist for experienced scientists and engineers with advanced degrees or equivalent experience.

- **ANALOG-DIGITAL PROGRAMMING**
- **FLIGHT TEST PLANNING-ANALYSIS**
- **DIGITAL SYSTEMS COMPUTER APPLICATION AND DEVELOPMENT**
- **ENVIRONMENTAL TEST**
- **CHECKOUT EQUIPMENT-TEST**
- **ELECTRONIC SYSTEMS AND DEVELOPMENT**
- **FLIGHT CONTROLS**
- **DYNAMICS ANALYSIS**
- **INSTRUMENTATION**
- **TELEMETRY**
- **MICROWAVE-ANTENNA DEVELOPMENT**
- **SOLID STATE ELECTRONICS**
- **GROUND SUPPORT**
- **OCEANOGRAPHY**
- **COMMUNICATIONS SYSTEMS AND INFORMATION THEORY**

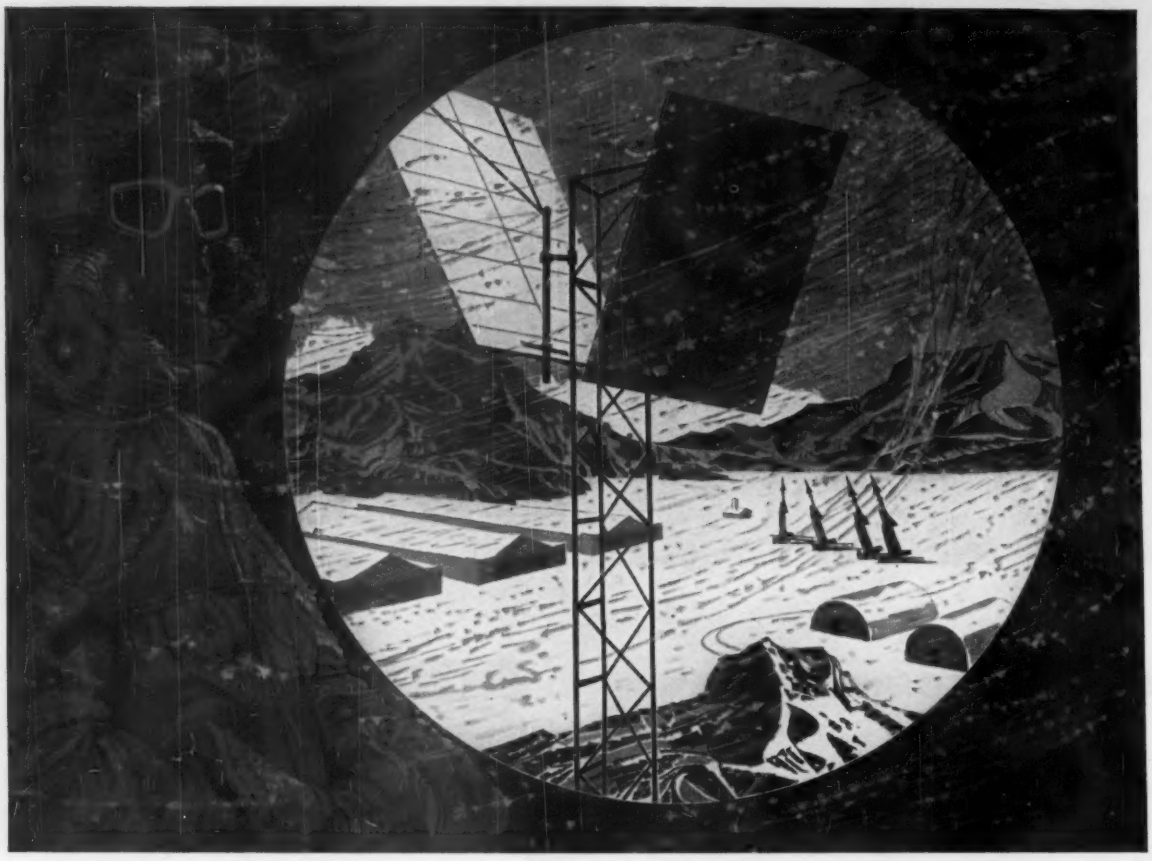
Mr. Vincent Iannoli and members of our Professional Staff will be available at the Convention Hotel. For personal interview while at the convention, phone PLaza 9-7211. If you are not attending the convention, send résumé to Research and Development Staff, Dept. C2-22. 962 W. El Camino Real, Sunnyvale, California.

OF SPACE TECHNOLOGY



(left) The Division's $3,500,000 advanced computer center is the most modern in the world. Equipment includes 8 analog computers and 2 Univac 1103A digital computers with complete support equipment.

Voice of defense in the North



Philco Microwave supports Nike control network across Alaska

Unaffected by the most severe winter storms . . . unhampered by rugged terrain . . . impervious to electronic jamming . . . Philco Microwave has been selected by the U.S. Army Signal Office to link Nike sites on the Alaskan Defense perimeter.

Advanced Philco CLR-9 microwave equipment assures extremely reliable electronic communication between these isolated guided missile outposts. Because it provides a completely reliable, uninterrupted communications system in this frozen land, Philco Microwave has become America's "voice of defense in the North."

At Philco, the world of tomorrow is *now*. To meet the challenge of advanced electronics research and engineering, Philco is pioneering advanced communications systems such as that developed for the Alaskan Nike sites. And, at Philco, engineering opportunities are also expanding—in the development of advanced communications systems, weapons systems and data processing.

Wherever you look at Philco; in guided missiles; in advanced navigation; in infra-red and radar technologies; as well as in communications systems . . . being "out front" is a habit.

In the wonder world of advanced electronics, look to the leader. Look ahead . . . and you'll choose Philco.

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GOVERNMENT & INDUSTRIAL DIVISION

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NEW

Oscilloscope for High-Voltage SURGE TESTING

TEKTRONIX TYPE 507

The Type 507 is a specialized instrument, designed primarily for high-voltage surge testing as applied to power transformers, high-voltage insulators, lightning arresters, and their associated design and acceptance tests.

Although the Type 507 has all the capabilities and features desirable for this type of work, slight modification of the instrument may be advantageous to meet the specific conditions encountered at some surge-testing facilities. Therefore, we recommend that you arrange with your Tektronix Field Engineer for an on-site demonstration.

TYPE 507 CHARACTERISTICS

DEFLECTION FACTOR—Approximately 50 v/cm to 500 v/cm in ten equal steps.

RISETIME—Approximately 5 mμsec.

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CALIBRATED SWEEPS—Eleven fixed sweep rates from 20 mμsec/cm to 50 μsec/cm.

HIGH ACCELERATING POTENTIAL—24-kv provides bright trace for photographic recordings.

6-CM BY 10-CM LINEAR DEFLECTION.

ELECTRONICALLY-REGULATED POWER SUPPLY.

PRICE, Type 507 . . . . . **$3000**

Includes one Type 500A Scope-Mobile and one common-bus ground connector.

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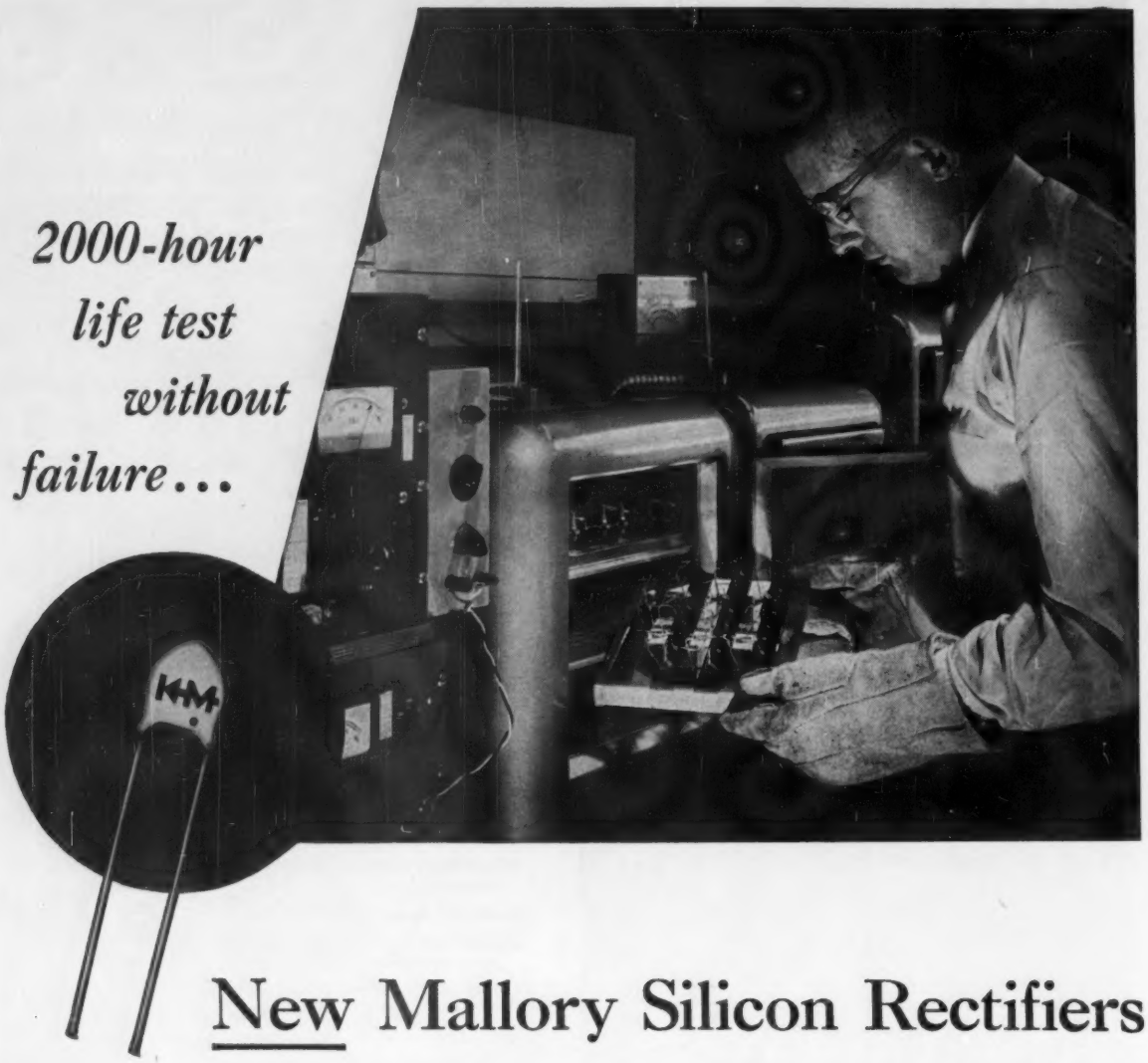
TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon., Seattle, Wash.; Hytronic Measurements, Denver, Colo., Salt Lake City, Utah.

Tektronix is represented in 20 overseas countries by qualified engineering organizations.

Tektronix manufactures seventeen other laboratory oscilloscopes, ten of which are also available as rack-mounting instruments. Several new oscilloscopes will be introduced at the March IRE Show. Be sure to see them at Booths 3027 to 3030.

2000-hour life test without failure...



New Mallory Silicon Rectifiers

How's this for reliability? After 2000 hours of life test in the ovens shown here —at 85° C ambient, with rated load switched on and off 1.5 million times— new Mallory Type T silicon rectifiers had not a *single* failure. Electrical characteristics stayed practically unchanged.

How's this for humidity protection? Type T rectifiers stand four times the humidity cycling of MIL-202A—take 500-hour boiling water immersion test without deterioration. New Mallo-Seal* encapsulating compound makes this possible.

How's this for performance? Type T's have forward drop of only 0.5 volt— reverse leakage of only 250 microamperes —at 85° C and with 0.5 amperes forward current.

How's this for price? Type T costs substantially less than other commercial grade silicon rectifiers.

*Trade mark of P. R. Mallory & Co. Inc.

Plug-in model, for fuse type clip mounting, is also available. Characteristics are the same as the Type T described above.

P. R. MALLORY & CO. Inc.
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P. R. MALLORY & CO. Inc., INDIANAPOLIS 6, INDIANA

electronics
MARCH 13, 1959

Looking Ahead in Engineering

Major international emphasis in research and development centers on solid-state devices, computers, microwaves, new components and materials. Look for new transducers, "thinking" computers, new point-to-point microwave techniques and monolythic circuits

By John M. Carroll, Managing Editor

IN THE COMING YEAR particularly significant new developments will appear in solid state, computers, microwave, components and materials.

Transducer development, in particular, has been spurred by missile and high-speed aircraft development. Devices are needed that provide precise measurement, high output and withstand extreme environments.

STRAIN GAGES—Silicon and germanium crystals provide extremely sensitive and flexible strain gages. As measured by gage factor (change in resistance ΔR/resistance R $\times$ strain per unit length S) sensitivity is 150 for germanium, 175 for silicon. This contrasts with gage factors of 2 and 4 for nickel-wire strain gages.

Semiconductor gages can measure static and low-frequency stresses as well

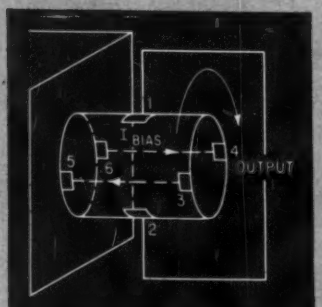


FIG. 1—Cylindrical germanium strain gage for measuring torsion

FIG. 2—Thermoelectric refrigerator for cooling infrared sensor

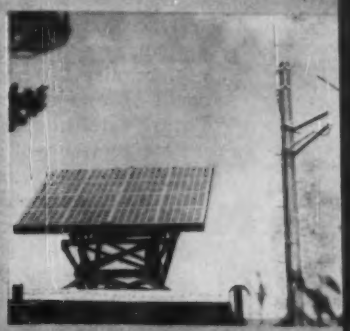


FIG. 3—Sun-powered transmitter-receiver for 150 mc

as higher-frequency stresses up to resonant frequency of the materials.

Germanium gages can operate up to temperatures of 600 K, silicon up to 1,000 K. Intermetallics such as gallium arsenide may work up to 1,400 K.

Semiconductor gages respond to torsional and shearing forces as well as tension and compression. In a cylindrical crystal gage, one end is cemented to solid support. Bias current flows from point 3 to 5 and 6 to 4 (Fig. 1). When torque is applied to the cylinder, an output voltage directly proportional to torque is measured between 1 and 2. (Bell Tel. Labs)

INFRARED DETECTORS—Lead telluride infrared detectors designed to respond to longer wavelengths can detect signals as low as 10^{-11} watt/cm^2 falling on photoactive surface.

Cell is cooled to −190 C by liquid nitrogen cryostat. (Minneapolis-Honeywell)

A photoelectromagnetic (pem) cell that operates at room temperatures provides about 1/10 the sensitivity of the low-temperature cell. The room temperature cell responds to even longer ir wavelengths than the lead telluride cell. (M-H)

PROXIMITY SWITCH — A solid-state proximity switch may be triggered by metal in its sensing zone. One model responds to ferrous metal, another to nonferrous metal.

The switch is a three-stage transistor circuit, a flip-flop and bridge oscillator. Circuit is potted in a ¾-in. diameter tube 4 in. long. A potentiometer at rear of unit adjusts sensing point. (Paramagnetics)

TRANSDUCER AMPLIFIER — An integral pressure transducer amplifier can work with a strain gage signal in the millivolt range. It has sufficient output to drive telemetry subcarrier oscillators and is miniaturized and ruggedized for missile and space-vehicle work. Currently, flight-test telemeters furnish 5 to 10 percent data. New amplifier may be able to help provide 1 or 2 percent data. (Stratham Labs)

ELECTRONIC COOLING—An electronic refrigerator is being used to induce a 50 F or more temperature drop in a lead-sulphide infrared sensor. The refrigerator works on the Peltier principle. Present units use a zinc-silver oxide battery for intermittent use, require 250 mv at 10 amp. Silicon rectifier could operate unit continuously from power line. Future satellites may be cooled by solar batteries.

Refrigerator cell is mounted on massive copper support disks equipped with cooling fins. The ir detector is fastened to the Peltier cold junction.

Suitable junction materials include bismuth-tellurium and alloys of zinc-antimony and bismuth-antimony. See Fig. 2. (Nortronics)

A major auto manufacturer currently is looking for a thermoelectric or electrochemical (hydrogen-oxygen) energy converter to substitute for lead-acid batteries in automotive and missile applications. (Chrysler)

SOLAR CELLS—In Japan, a 70-w (maximum capacity) solar battery shown in Fig. 3 is used to power a transistorized 150-mc transmitter-receiver. The solar battery has 4,320 silicon cells each 28 mm in diameter. The solar battery is used to charge a nickle-cadmium storage battery. The station can go without sunshine for a month and still operate. Located atop a mountain in the heart of the city of Kukushima, it relays messages to public utility service cars. (Nippon Electric)

A commercial solar photovoltaic cell for use in computers is underway. So also is work on solar energy power packs for satellites and space ships. New materials, and particularly new ferrites are under study. (Hoffman)

HIGH-FREQUENCY TRANSISTORS — At least three new transistor structures promise major advances in vhf and uhf circuits.

Germanium mesa transitors, for example, feature alpha cutoff frequencies up to 750 mc and power dissipations of 750 mw.

High heat dissipation is obtained through direct contact between header and transistor element, which consists of germanium, aluminum and gold.

Gaseous diffusion and high-vacuum manufacturing techniques combine with the undercut base-emitter "mesa" shape to provide high frequency response and fast switching speeds. (Texas Instruments)

Commercial availability of MADT transistors provides oscillators and amplifiers useful in the vhf and uhf ranges. The name stands for microalloy diffusion transistor. Both the microalloying and chemical etch process used in surface-barrier transistors and diffusion techniques contribute to high frequency performance. (Philco)

TECNETRON—In France, work continues on the Tecnetron, a three-element field-effect-cutoff semi-

FIG. 4—Computer with 50-mc clock rate uses coaxial-cable delay lines

conductor device. Its theoretrical upper frequency limit is over 10,000 mc. In its present state of development, the Tecnetron has been used in a 30-mc amplifier, 130-mc oscillator with several milliwatts output. Improvements should shortly extend the device's practical frequency limit well above 1,000 mc.

TRISISTOR—A new semiconductor fast-switching device is the Trisistor, an alloyed-junction *pnp* device the collector of which is a conjugate emitter, i.e., capable of electron injection into the base. It is also possible that the device makes use of the avalanche principle.

Device characteristics resemble those of thyratron electron tube. Switching times are in millimicrosecond range.

Trisistors can be used as sensitive relays in power-switching circuits, in half-wave or full-wave d-c phase-controlled circuits and in synchronous d-c/a-c conversion.

MICROWAVE COMPUTERS — Manufacturers are pushing computer clock rates higher and higher. This is bringing about development of faster switching devices and memory devices with shorter write-read cycle times. One source of impetus is the Nike-Zeus anti-ballistic-missile program.

One computer manufacturer has a developmental 50-mc clock-rate computer. The unit seen in Fig. 4, usess secondary-emission pentode vacuum tubes and coaxial-cable delay lines. (IBM)

Another manufacturer has a 10-mc computer, is working on a 100-mc unit. This firm feels computers with S-band clock rates are possible. They are developing memory cells using molecularly thin magnetic films to substitute for magnetic-core logic circuits. (Sperry Rand)

PARAMETRONS—A new Japanese computer uses 5,000 parametron circuits. A parametron consists of a set of tiny ferrite toroids, a capacitor and resistor.

When excited at a frequency f, the parametron oscillates at a clock frequency $f/2$ which is either in phase or 180-deg out of phase with the driving frequency. The phase difference is determined by a control signal and denotes a binary ONE or ZERO.

Clock frequency for a parametron computer is usually 4 mc. (Nippon Tel. & Tel.)

LINEAR ACCESS — A magnetic-core array with linear selection is the heart of a memory unit with one microsecond cycle time.

With linear selection, a single word is selected from a memory directly. Conventional coincident current methods require that currents from different sources be passed through a group of words.

Word capacity of a memory under development will be 8,000 words, 80 bits a word. (Telemeter Magnetics)

IMPULSE SWITCHING—Fast memory access time can be provided by incompletely magnetizing conventional ferrite cores. The cores are overdriven in one direction. Width of pulse governs amount of material switched.

Memory cycle times of 0.3 microsecond have been achieved. New *pnpn* diodes are used as core selection elements. (MIT)

FOLDBACK MEMORY—High degree of noise cancellation is achieved in a high-speed printer system by gluing magnetic cores into receptacles within a U-shaped plastic frame. Cores are placed so that wires intersect them at right angles.

SUPERCONDUCTORS—Thin evaporated films form the superconductor of new memory elements. Drive and pickup wires are linked inductively to the film. Current pulses in drive wire set up either clockwise

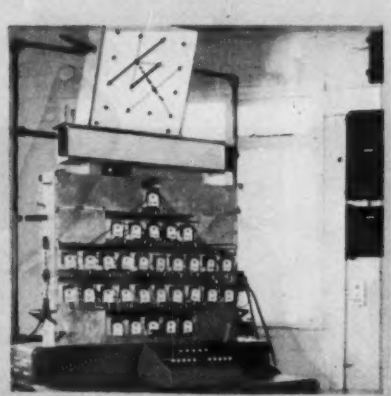


FIG. 5—Probability computer represents one step towards a true electronic brain

FIG. 6—Traveling-wave amplifier has 10-kmc bandwidth at 55 kmc

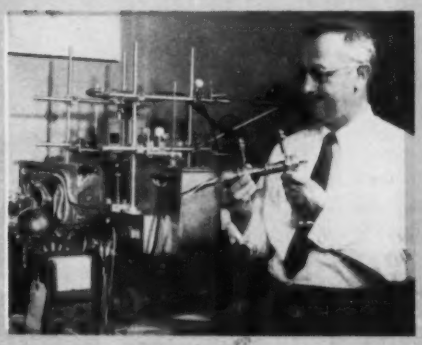


FIG. 7—Waveguide transducer for launching transverse-electric circular mode

or counterclockwise persistent currents in the supercooled film. Only clockwise currents produce output. Switching times are on the order of 10^{-9} sec. (Royal Radar Establishment—Brit.)

THINKING MACHINES—Neurophysiological studies of a frog may help computer designers one day to simulate the human brain.

One set of frog neurons is of special interest. The neurons, fed by the optic nerve, abstract position and velocity data. The frog leaps automatically at any moving object smaller than he is, away from anything larger. Special circuits such as an electrometer cathode follower are essential to this work. Outcome may be highly useful in antimissile missiles. (MIT)

PROBABILITY COMPUTER—Imitation of learning techniques is going on with a computer (Fig. 5) that records frequency of occurrence of 5 events. When any fresh set of events occurs, capacitor storage devices determine the conditional probability of other events occurring at the same time. First use will be in control of an oil refinery distillation column. (Natl. Physical Lab—Brit.)

TRAVELING-WAVE TUBES — One of the most promising means of establishing a wideband communications link between two points would be to use the transverse-electric mode of propagation in a circular wave guide.

A traveling-wave tube now under development provides c-w powers ranging from 125 to 200 mw at 55 kmc with a bandwidth of 10 kmc. The tube uses a 7-kv, 3-ma beam projected through a 4-in. helix with a 15-mil bore. See Fig. 6.

With a magnetic focusing field of 1.5 kilogauss only 5 percent of beam current is intercepted by the helix. (Bell Labs)

MODE TRANSDUCER—A French three-part mode transducer shown in Fig. 7 converts a TE_{on} rectangular wave into a TE_{m} circular.

First section changes from a small vertical rectangular cross section to a larger horizontal one. Second part changes in cross section from rectangular to a cross. Third section changes from the cross to a circle.

PHASE SHIFTER — A microwave phase shifter promises to improve electronic scanning of vhf and uhf radar antennas. The shifter consists of two 8-in. diam. metal disks. Between the metal disks are two semicircular disks of dissimilar dielectric. Between the dielectric semicircles are several concentric semicircular two-dimensional transmission lines.

The transmission lines remain stationary as the dielectric semicircles rotate at 18,000 rpm. Relative phase between transmission line input and output is changed by changing the effective dielectric constant of the surrounding material. (AF Cambridge Research Center)

MASERS—There seems to be a distinct advantage in using maser amplifiers above 6 kmc, parametric amplifiers below about 1 kmc.

Recent maser developments include portable maser amplifiers and traveling-wave masers. New fundamental designs are in the works, including a multiple microwave pumping scheme using four energy levels instead of two or three. (MIT)

Certain paramagnetic materials have four energy levels. The four-level maser uses all four levels, takes advantage of all electron spins. In such a maser, the pumping frequency can be increased and a large ratio of pumping-to-operating frequency improves the gain-bandwidth product of the device. Push-push or push-pull techniques can be used for multiple pumping. A four-level maser will be delivered to the Air Force in April. (Ewen-Knight)

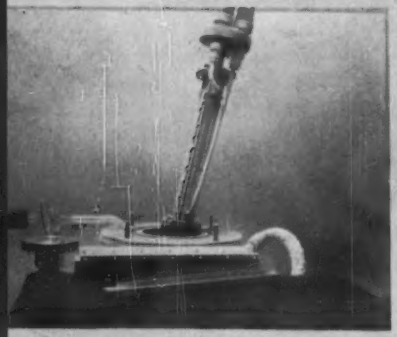


FIG. 8—Traveling-wave maser offers low-noise possibilities at superhigh frequencies

FIG. 9—Electron-beam parametric amplifier (mavar) for 500 mc

FIG. 10—Crimped polyethylene coaxial cable resists water penetration even under pressure (French)

RUBY TWM—To overcome some of the limitations of bandwidth and gain in the cavity-type maser, a traveling-wave maser (Fig. 8) has been developed that can be tuned over a frequency range, determined by the slow-wave structure, simply by changing the pump frequency. This ruby twm has a net gain of 23 db with a bandwidth of 25 mc. By tuning the pump frequency from 18.9 to 19.5 kmc a tuning range of 350 mc centered about 5.9 kmc is obtained. Its reverse loss is 29 db and output power begins to saturate at about 22 dbm. (Bell Labs)

MAVARS—Work continues on electron-beam parametric amplifiers for uhf. Investigators report the beam-type amplifier is unconditionally stable and that band-pass characteristics are independent of gain. Input and output resistances are positive under all conditions. Tubes for 420 to 780 mc are in production. Fig. 9.

Work is underway to make an electron-beam mavar in which the idler channel is much higher in frequency than the signal channel—presently the pumping frequency is approximately half the signal frequency, thus the idler and signal channels are close together. (Rauland Corp.)

Work continues on developing low noise diodes for diode-type mavars. Noise temperatures as low as 50 K for room-temperature diodes have been obtained in a high-gain 3-kmc mavar. (Hughes)

MONOLYTHIC CIRCUITS—In components manufacturing, materials that can be passed into functional forms from slurries and powders and materials that can be evaporated onto functional forms are receiving close study.

Object is to fit the shape of a component to the modular form of the equipment just as printed-circuit boards make the wiring fit the desired form.

The ultimate would be blocks of material pressed or extruded from plastic, ceramic, ferrite and/or semiconducting material. These blocks would perform such functions as amplifying or oscillating without any external circuitry.

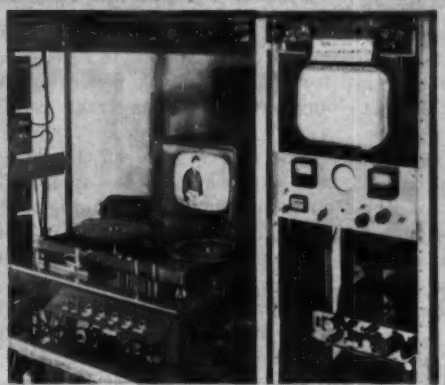


FIG. 11—Video magnetic tape recorder with 30-db, or better, signal-to-noise ratio

A TRULY INTERNATIONAL ART

Any electronic engineer worth his sliderule is aware that no one company, community or country has a monopoly on research talent in our field.

It is nevertheless revealing to see how developments in different corners of the globe fit together into distinctive trends.

This article illustrates many such patterns. It confirms the truly international character of electronic engineering.

Only a far-flung network of technical editors—ELECTRONICS staff editors in New York, Boston, Chicago and Los Angeles; technically trained McGraw-Hill bureau personnel in Detroit, Dallas, London, Paris, Bonn and Tokyo—could have gathered the material in this article

TITANATE STACKS—A British firm is experimenting with a process in which stacks of barium titanate are made with a base metal such as nickel or iron forming the electrodes. Units with capacitance-per-unit-volume ratios of 4 to 8 $\mu f/in^3$ have survived 250 v d-c at temperatures up to 100C. (Plessey)

PICTURE TUBE FOR TRANSISTOR TV—A high transconductance tube using, in the gun, a space-charge grid following the cathode requires less than 10 v drive to modulate 1 ma of beam current. The tube is expected to be important in transistor tv receivers. (Rauland)

In another picture tube, use of a strong post-acceleration lens to reverse and magnify the scan may reduce scanning power requirements for portable sets. It may also permit use of shorter picture-tube envelopes. (Rauland)

F-M SERVO—A system of servos using frequency modulation has been found not subject to pickup of harmonics.

A gearless recorder, built on this principle, will cover full scale in ¼ sec and yet follow infinitesimal adjustments slowly. About the size of a briefcase, the recorder uses conventional frequency modulation techniques. (Parametrics)

OTHER DEVELOPMENTS—In Japan, a video magnetic tape recorder is under test that has a signal-to-noise ratio of 30 db or better without jittering. (Sony) Unit is shown in Fig. 11.

From Dresden, East Germany, a high-yield electron-addition ion source is disclosed. The electron enrichment is brought about by compressing a low-voltage gas-discharge plasma with an inhomogenous magnetic field. Creation of these negative-ions has aided in development of a molecule mass spectrograph that can register molecular weight differences of one atom at molecular weights over 1,000.

Digital Memory System

Magnetic disk memory, used in small low-cost digital computers with memory capacity of 50 to 100 words, uses simple control and selection circuits. Read-write circuits employ new principle. The magnetic head itself is the transformer of a blocking oscillator circuit

By **T. C. CHEN and O. B. STRAM,** Burroughs Corporation Research Center, Paoli, Penn.

THIS MAGNETIC MEMORY uses a flat-surfaced aluminum disk that contains radially spoked magnetic segments that can store from 50 to 100 words. Circuits are kept simple by employing a new principle wherein the magnetic head itself is the transformer of a blocking oscillator circuit. Read-write circuits require only one twin triode for each magnetic head. Selection is controlled directly by an externally programmed paper tape. No relays or diode networks are required.

Interference in a reading channel, due to the writing signal in an adjacent channel, usually presents a difficult problem in conventional disk or drum memory systems using a uniform magnetic medium. In the described system, the blocking oscillators are normally biased beyond cutoff and the problem of blocking the reading amplifier by strong writing interference does not exist.

Although there is a read-write circuit for each magnetic head, the simplicity of the circuit and lack of complicating networks make it possible to produce a system at a lower cost than a comparable conventional magnetic disk or drum memory.

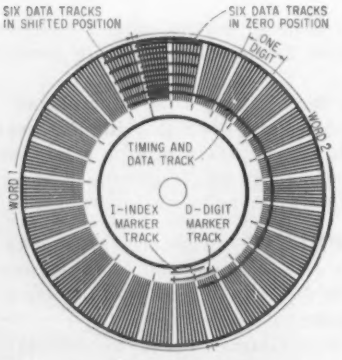


FIG. 1—The magnetic-spoke pattern on the memory disk supplies data tracks for the main store, the digit marker and disk index marker pulses. The system uses a decimal-pulse counting code with a word length of twelve digits, plus one digit for sign

Disk Pattern

The magnetic spoke pattern on the disk is shown in Fig. 1. There is one spoke for each bit of the words to be stored. The overall system uses a decimal pulse-counting code with a standard-length word of twelve digits plus one digit for sign. Each magnetic track is divided into two words, making a total of 26 digit groups, or 260 bit positions for each complete track. The tenth spoke, or physical bit, of each digit group is omitted in the data recording areas of the disk, but is supplied by a separate track which has a spoke only in the tenth position of each digit group and which also supplies the *d* or digit marker pulses.

The other marker track has only two spokes and provides the disk index and word marker pulses. There is no special track set aside for the main clock generator, but any arbitrary data track can be used.

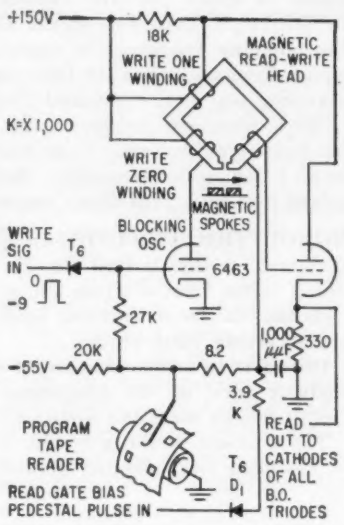
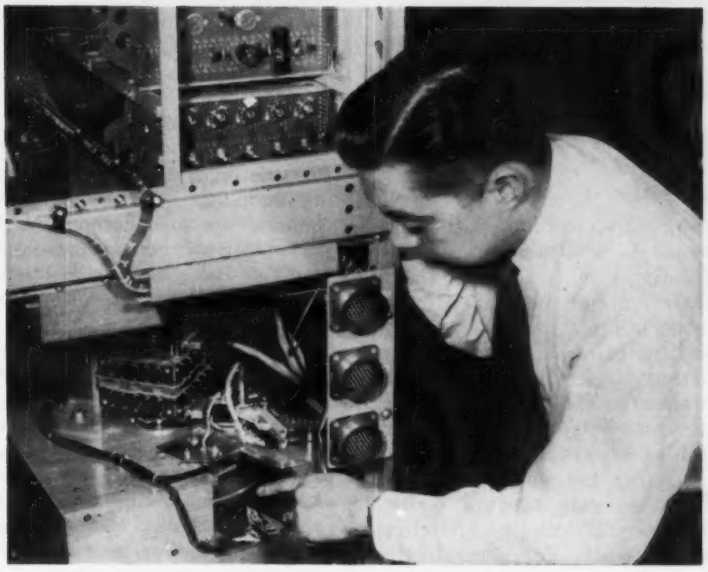


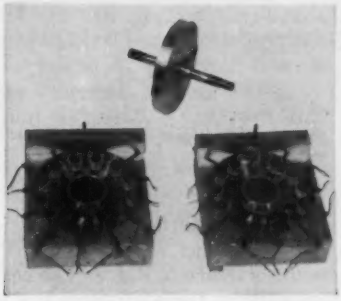
FIG. 2—Blocking oscillator read-write circuit. Magnetic head selection is controlled directly by a program tape, eliminating relay or diode networks

The reverse side of the disk is also divided into two areas. The outer area has the remaining twelve data tracks of the main store while the inner one has two additional data tracks which are located in the same relative positions as the word and digit marker tracks on the front side of the disk.

The disk rotates at 3,600 rpm, so that the period between spokes is 64 μsec. The ratio of stripe to

Keeps Circuits Simple





Disassembled transformer distributor shows planes and cursor disk

Engineer demonstrates the new magnetic disk memory developed for low cost computers

total period is 3 to 7 so that a spoke is under the reading head for 27 μsec.

The 24 tracks of the main data store are scanned by two blocks of magnetic read-write heads. Each block of heads has six, $\frac{1}{4}$-inch wide cores spaced on $\frac{3}{8}$-in. centers and arranged so that their gaps fall along a radius of the disk. Track interlacing is achieved by physically shifting the entire head block between two stable positions by a pair of solenoids, so that the six heads scan 12 tracks.

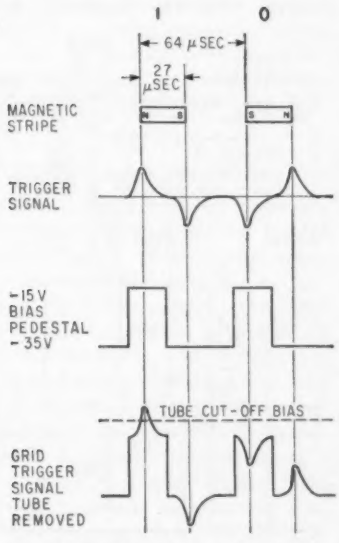


FIG. 3—Waveform of the read gate bias, or pedestal pulse, used to discrminate between ones and zeros

In addition to the two shifting head blocks there are two fixed head blocks, one on each side of the disk. One fixed head block contains the read heads for the index and digit markers and for generating clock pulses from a data track. The other fixed head block contains two read-write heads for auxiliary store which is required by the computer system of which the memory is part.

The magnetic recording disk and the read-write heads are designed to give the maximum possible read-back signal at the relatively low frequency of the memory. This large signal is obtained by the following means: the track width is $\frac{1}{8}$ inch; the head core is made of Moly-Permalloy lamination; the writing surface is discontinuous, to provide a sharply defined pole at the edges of the spokes; the magnetic material is a nickel-cobalt alloy having a remanence flux density of 8,000 gausses and a coercive force of 180 oersteds; the magnetic material is plated to a thickness of 0.002 inch; and a head-to-disk spacing of 0.0005 inch is maintained by air guiding.

Under these circumstances, a read-back signal at the open terminal of the 950-turn grid winding is 15 to 20 volts peak-to-peak, depending upon the distance at which the head is located from the center. Air guiding of the head packages requires that the spaces between the spokes be filled in so as to provide a flush surface.

The magnetic pattern on the memory disk is formed by applying photosensitive resist on the surfaces of the aluminum disk. Optical masks are placed over the surfaces and the assembly is exposed to light. The unexposed portion of the resist is then dissolved and nickel-cobalt alloy is electroplated onto the

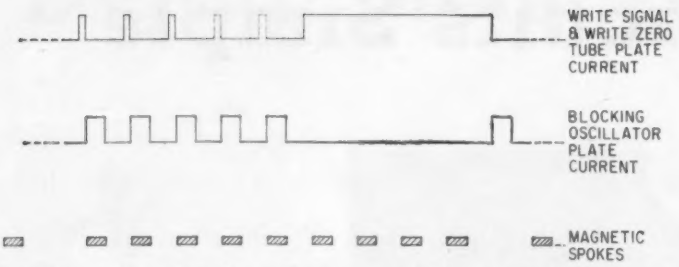


FIG. 4—Write signal and blocking oscillator current pulses. A decimal 5 is used in this example

bare portions of the disk.

Each channel of the read-write circuit is shown in Fig. 2. The head core with its three windings can be considered as a blocking oscillator transformer. Cathodes, connected to a common cathode resistor, provide the read output.

The experimental computer, in which the memory system is installed, is externally programmed by a paper tape. One of the address levels of the tape reader has twelve brushes, each connected, as shown, to one of the read-write circuits.

Grounding any brush of the selected channel, through an appropriate hole in the program tape, immediately operates the circuit to which it is connected without the use of relays or decoding circuits.

As a saturated spoke of the disk passes under the active gap of the reading head, a large signal is induced in the grid winding. If the grid is biased just below cutoff, the positive-going portion of the signal causes the tube to conduct and draw current through the plate winding and the circuit functions as a blocking oscillator. One pulse is produced across the cathode resistor for each signal read from the disk. The cathode current during the conduction part of the oscillator cycle has a maximum value of 40 ma and a duration of 20 μsec.

It is important to keep the resolving time of the circuit to a minimum because of the high duty factor of the circuit, about 30 percent for continuous reading.

The memory operates on a return to zero basis, since the spaces between spokes are not magnetic. ONES and ZEROS are stored by saturating the spokes in opposite directions. Both ONES and ZEROS consequently give read-back signals. Waveforms of the read gates are shown in Fig. 3. A ONE signal has a positive pulse at its leading edge. Gating logic discriminates between ONES and ZEROS and prevents the positive-going pulses at the trailing edge of a ZERO spoke from triggering the blocking oscillator. The read gate bias, or pedestal pulse, is applied to the grid circuit of the triode. The upper level of the pedestal pulse is synchronized with the leading edge of the magnetic stripe. If the pulse at the leading edge of the spoke is positive, indicating a ONE, it combines with the pedestal voltage to cause the grid voltage to exceed the cutoff bias, thus triggering the blocking oscillator.

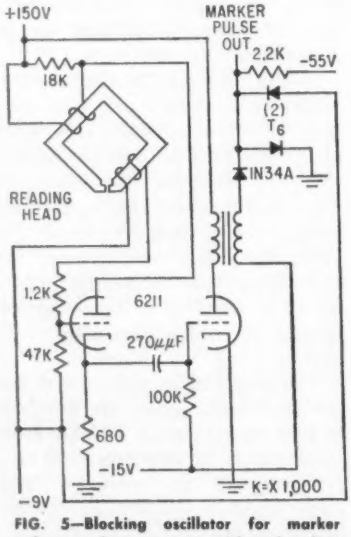


FIG. 5—Blocking oscillator for marker pulses used to generate either the digit pulses of the word or index marker pulses

The positve pulse at the trailing edge of a ZERO spoke occurs between two pedestals and will not trigger the blocking oscillator. The pedestal bias pulse is supplied to all blocking oscillators through individual diodes and voltage dividers controlled by correspondng magnetic head brushes of the tape reader.

The excursion of the pedestal pulses is from −35 v to −15 v so that the input diodes of the blocking oscillators of all the unselected channels are held cut off by the −55-v supply, thus preventing reading. Positive-going pulses of the write signal swing between −9 v and ground.

A ONE bit is written by a short pulse applied to the grid of the write-zero tube. The trailing edge of the plate-current pulse of the write-zero tube generates a large positive voltage pulse at the grid of the blocking oscillator and triggers it. The timing of the trailing edge of the pulses applied to the grid of the write-zero tube is such that the plate-current pulse of the blocking oscillator starts just before the leading edge of the corresponding spoke reaches the gap of the magnetic head. The ensuing blocking oscillator current pulse writes a ONE bit on the spoke passing over the magnetic gap.

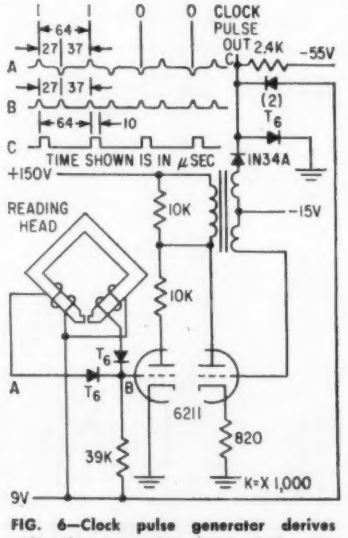


FIG. 6—Clock pulse generator derives pulses from a reading head which scans the data track, eliminating need for a separate timing track

A decimal digit is represented by the number of consecutive ones starting at the beginning of a digit group of nine spokes. The remainder of the group is written as ZEROS, which is accomplished by energizing the write-zero tube continuously for the interval required to write the ZEROS. Figure 4 shows the timing of the write signal and the plate-current pulses. A decimal five is used in this example.

Digit and Word Circuit

Index and digit marker pulses are generated by blocking-oscillator circuits, Fig. 5, similar to those used for data tracks. The duration of these pulses is 10 μsec with a 2 μsec rise time. A driver stage provides sufficient power to drive a large number of transistor logic circuits in the computer.

The clock pulse is derived from a reading head which scans a data track, so that there is no need for a separate timing track. It generates a pulse for every magnetic spoke passing over the gap of the reading head regardless of whether the spoke is written with a ONE or a ZERO. The circuit diagram is shown in Fig. 6. Clock pulses are generated only at the leading edges of the spokes.

The initial writing of the timing track and marker tracks is done by applying a direct current to the magnetic head of the track involved, since the bit locations are physically present as discrete areas on the disk.

Transformer Distributor

The magnetic memory bits are distributed sequentially to twelve demical stages of a parallel magnetic accumulator used in the computer. In other words, the nine serial bits associated with a digit are sent to the stage of the accumulator associated with digit one, and so forth. This distribution is accomplished by the rotary transformer distributor, composed of a number of U-shaped ferrite cores arranged radially as shown in Fig. 7. The photograph shows the construction of the unit. All the U-core legs which are at the inner diameter of the assembly are encircled by a common primary coil, while each outer leg has its own secondary coil.

The 24 cores are arranged in two planes of 12 cores each, each having its own primary and cursor. A ferrite bar, called the cursor, is caused to scan over the open faces of the legs of the U core, momentarily bridging the two legs of each U core successively. During the time that the cursor is engaged with any one U core, information fed into the common primary coil is read out of the secondary coil on that core only.

The transformer distributor has one U core and secondary coil for each digit segment on the disk, making 24 transformers in all. The sign digits are not read into the accumulator, but space is set aside for them in order to maintain synchronization. The cursor is synchronized with the memory disk, and is the only moving part of the distributor. The cursor is embedded in an aluminum disk which provides eddy current shielding for the unengaged secondaries. The cursors are displaced 180 deg from one another.

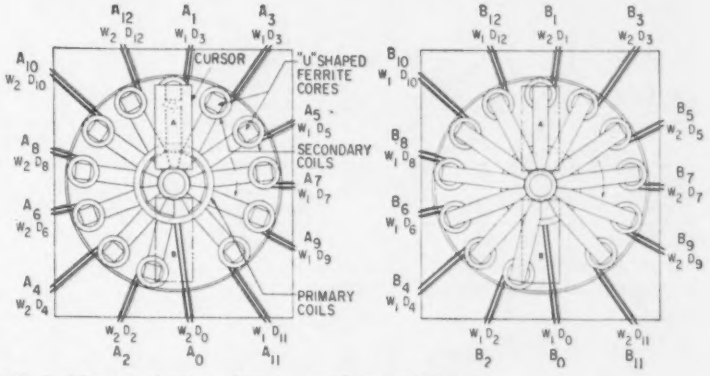


FIG. 7—Schematic drawing of rotary transformer distributor

Operating Sequence

In Fig. 7, the secondaries are marked by W and D which denote the words and digits of a memory track respectively. The sequence of operation during one revolution of the cursor disk is as follows: A_1, B_2, A_3, B_4 . . . A_{11}, B_{12}, A_0, B_1 . . . A_{12}, B_0, A_1. The cores at sign digit positions A_0 and B_0 are left out since the sign digits are not distributed through the transformer distributor.

The secondaries A_1 and B_1 are mixed at the input of the digit *1* channel of the accumulator, likewise A_2 and B_2 are mixed into the digit *2* channel, etc., so that in rotating through 180 deg, each digit of the word on the memory disk is distributed to the appropriate stage of the accumulator.

During the nth digit time associated with, say the B_n secondary, there is no appreciable modulation of the bit pulses at the secondary terminals caused by the moving cursor. Two digit times later when the same primary is again energized for the $(n + 2)$th digit, there is some residual crosstalk in the B_n secondary caused by the fact that the cursor which is engaged with $B_n + 2$ is still in the proximity of B_n. The signal to crosstalk ratio is greater than 4 to 1, but the unwanted signal is easily removed by a clipping circuit.

It is not necessary to have a driver stage on the output of each channel. The accumulator stages are driven by the transformer distributor primary drivers, resulting in a saving of ten drivers over conventional distributors using counters and gates.

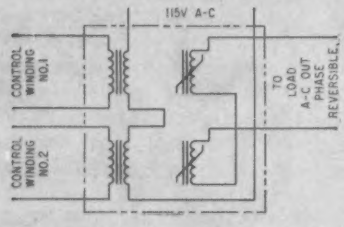
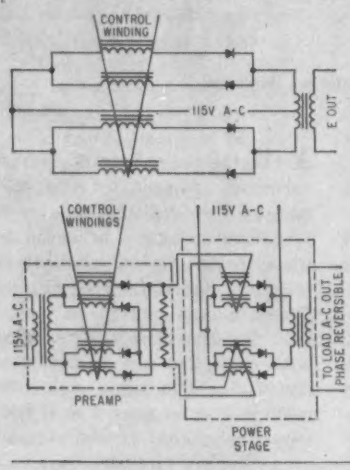
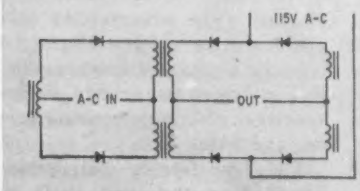
The transformer distributor is mounted on the same shaft with the memory disk.

Magnetic Amplifiers

Seven different combinations of magnetic-amplifier units of the push-pull variety are compared for important characteristics

By **SAMUEL DAVIS,** Magnetic Amplifiers, Inc., New York, N. Y.

TABLE I—Commercially Available Push-Pull Magnetic Amplifiers for Servo Systems

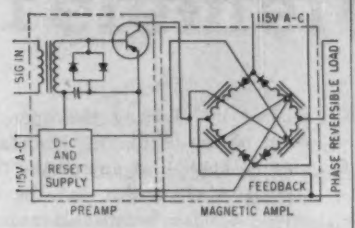
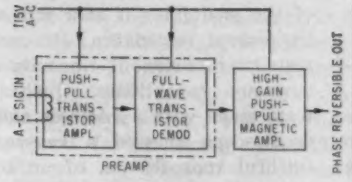
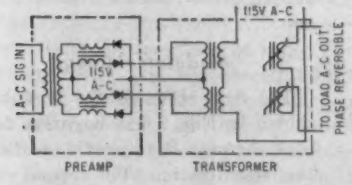
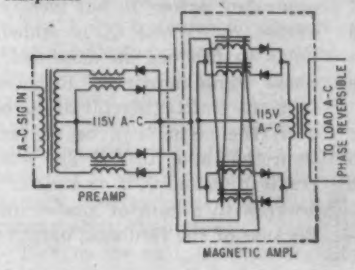
Type and Simplified Schematic	Description	Power Out in watts	Power Gain	Volume in cu. in.	Weight in lb.	Response Time	Sensitivity
Push-Pull Saturable Transformer 	Basic type of magnetic amplifier. Essentially an inductor with a saturable ferromagnetic core using nonlinear magnetization curve of a ferromagnetic material. Low gain and long response time.*	400 cps 3.5 to 100	18 to 90	5.1 to 80	0.75 to 9	0.03 to 0.1	8 ma d-c into 3,300 ohms to 15 ma d-c into 5,800 ohms
		60 cps 20 to 2,000	16 to 200	78 to 750	8 to 55	0.1 to 0.6	10 ma d-c into 5,600 ohms to 60 ma d-c into 2,500 ohms
High-Gain Push-Pull Magnetic Amplifier 	Addition of load current feedback in form of self-saturation or external feedback to saturable reactor results in a high-gain magnetic amplifier.* Time constant is function of L/R ratio of control winding inductance and total control circuit resistance	400 cps 3.5 to 2,500*	2.9×10^5 to 1×10^8	37.5 to 1,458	3.5 to 75	0.08 to 0.02	0.4 ma d-c into 560 ohms to 2.5 ma d-c into 250 ohms
		60 cps 5 to 2,500*	2.2×1^4 to 1.6×10^8	75 to 2,500	6.4 to 130	0.5 to 0.1	0.6 ma d-c into 630 ohms to 2.5 ma d-c into 250 ohms
		*Two-stage magnetic amplifier and chassis					
Push-Pull Fast-Response Magnetic Amplifier 	Self-saturating magnetic amplifier of flux-reset type. Characterized by 3/4 cycle average time delay. Time delay is independent of control winding inductance.	400 cps 3.5 to 30	400 to 800	26 to 58	3 to 5	0.002	3.5 v a-c into 300 ohms to 2.5 v a-c into 250 ohms
		60 cps 5 to 50	10^3 to 1.5×10^3	60 to 144	5.5 to 13	0.01	2.25 v a-c into 2,500 ohms to 2.5 v a-c into 250 ohms

for Servo Systems

STATE OF THE MAGNETIC-amplifier art has advanced to a point where packaged solid-state 60- and 400-cps servo systems are offered in extensive lines. Given basic specifications such as input, load and response time, an engineer can obtain a completely packaged system to fulfill all his servo needs.

Another factor of importance is the ease with which standard magnetic-amplifier units can be modified to meet special requirements. This is achieved by building-block design in each system.

Advantages of the solid-state units over vacuum-tube amplifiers include high reliability, flexibility of multiple inputs, instantaneous start and minimum standby power requirements.

Type and Simplified Schematic	Description	Power Out in watts	Power Gain	Volume in cu. in.	Weight in lb.	Response Time	Sensitivity
Push-Pull Transistor Preamplifier plus Fast Response Magnetic Amplifier 	Flux-reset fast-response magnetic amplifier is driven from a phase-sensitive transistor preamplifier resulting in a high-gain, minimum-delay amplifier.	400 cps 3.5 to 30	 5×10^4 to 1×10^6	 6.4 to 35	 0.75 to 3	 0.002	 1 v a-c to 0.08 v a-c into 5,000 ohms
Push-Pull Transistor Preamplifier plus High-Gain Magnetic Amplifier 	Response time is essentially $L/R + R_f$ where L is inductance of control winding, R is control-winding resistance and R_f is equivalent output resistance of transistor amplifier.	400 cps 5 to 2,500*	 5×10^4 to 2.7×10^6	 60 to 1,458	 4.5 to 75	 0.008 to 0.005	 0.8 v a-c to 0.3 v a-c into 10,000 ohms
		60 cps 5 to 2,500*	 5×10^4 to 2.7×10^6	 80 to 2,500	 7.5 to 130	 0.07 to 0.05	 0.8 v a-c to 0.3 v a-c into 10,000 ohms
		*Two-stage magnetic amplifier and chassis					
Fast-Response Magnetic Preamplifier plus Saturable Transformer Power Stage 	This combination uses fast response qualities of flux reset type magnetic amplifier to drive saturable transformer as a power stage.	400 cps 3.5 to 100	 10^3 to 6×10^3	 17 to 105	 1.5 to 10.25	 0.03 to 0.08	 0.8 v a-c to 2.5 v a-c into 600 ohms
Fast-Response Magnetic Preamplifier plus High-Gain Push-Pull Magnetic Amplifier 	This combination incorporates flux reset fast-response magnetic amplifier and high-gain self-saturating magnetic-amplifier power stage.	400 cps 5 to 2,500*	 3×10^3 to 1×10^6	 75 to 1,458	 5 to 75	 0.008 to 0.02	 0.6 v a-c into 600 ohms to 0.5 v a-c into 10,000 ohms
		60 cps 5 to 2,500**	 5×10^4 to 2×10^5	 90 to 2,376	 5.75 to 130	 0.08 to 0.1	 2.5 v a-c into 10,000 ohms to 0.5 v a-c into 2,000 ohms
		*Two-stage magnetic amplifier and chassis **Three-stage magnetic amplifier and chassis					

Lower power requirements for transistorized telemeter transmitter and modulator reduce battery weight of balloon-borne radiation-detection gear. Frequency stability and modulation consistency are better for the transistor unit than for the vacuum-tube unit it replaces

By **DONALD ENEMARK**, Physics Department, State University of Iowa, Iowa City, Iowa

Transistors Improve

DESIGN GOALS of reduced weight and improved reliability of balloon-borne electronic apparatus used in connection with ionizing radiation detectors led to development of a fully transistorized telemetry system.

The transistorized unit proved superior to earlier vacuum-tube types for this application and may be useful in other equipment. Frequency stability was better, modulation was more consistent, and overall efficiency was about three times higher. As a result of the higher efficiency, battery weight was greatly reduced.

The f-m transmitter provides 250 mw at 92 mc. Output power represents a compromise between the need to override considerable local interference and the limited weight available for batteries. Although output power is less than that of the vacuum-type type, the signal is stronger, presumably because of the antenna used.

Transmitter

Two WE GF 45011 transistors are used in the transmitter shown in Fig. 1. A variable-frequency oscillator was used because only moderate stability was required and because frequency modulation was to be used. The tapped capacitor or Colpitts configuration proved to be the most stable and reliable over wide temperature changes.

Feedback from collector to emitter of Q_1 is obtained from capacitive divider C_1, C_2. The ratio of C_1 to C_2 was determined experimentally, the criterion being reliable starting of the oscillator under load conditions at all temperatures in the operating range. The modulation signal is injected at the base of the oscillator.

Output of oscillator Q_1 is inductively coupled to the amplifier by L_1 and L_2. Since there was excess drive available from the oscillator, no great effort was made to optimize this circuit. Because of this drive, C_3 must be detuned to prevent instability in the oscillator.

The output amplifier is a conventional grounded-base stage. Inductive coupling from amplifier to antenna was tried, but results were poor. The tapped coil with capacitive coupling was the most efficient arrangement found. Collector efficiency of the output stage was about 50 percent, and overall package efficiency was about 33 percent.

Transistor selection was necessary for the amplifier. About half the transistors received operated with reasonable efficiency in the output stage. All figures given are for an average transistor.

The transmitter was tested over the temperature range of −50 to +125 F with not over 15 percent change in power output.

Frequency modulation is accomplished by shifting the operating point of the oscillator. Modulation may be applied at any of the three transistor electrodes, but the base input is used because it requires the least power for a given amount of deviation.

The most important requirement of the modulator is that it have a low output impedance. No careful tests were made of linearity and deviation capabilities. Qualitative tests made with a receiver and an oscilloscope showed a reasonably faithful reproduction of an input sine wave. Maximum deviation depends somewhat on individual transistors, but in all cases was at least 200 kc before severe distortion began.

Modulator Circuit

The first stage of the modulator shown in Fig. 2 has negative feedback through R_1 to provide some d-c bias stabilization. The second stage is somewhat unconventional. Transistor Q_2, in the absence of Q_3, would act as a amplifier with some signal appearing across R_2 but most of it across R_3. When Q_3 is added, it tends to produce an amplified, in-phase signal across R_2. Because R_2 is in the emitter circuit of Q_2, however, the signal can be no larger than the input to Q_2. The overall result of Q_2 and Q_3 is an emitter follower with a gain of almost unity. Because of the feedback, output im-

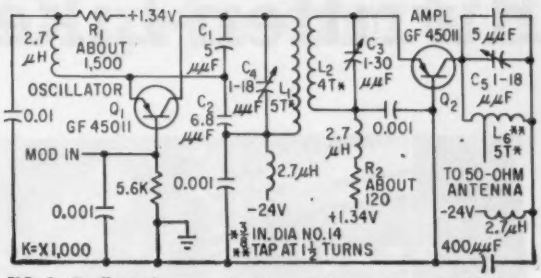
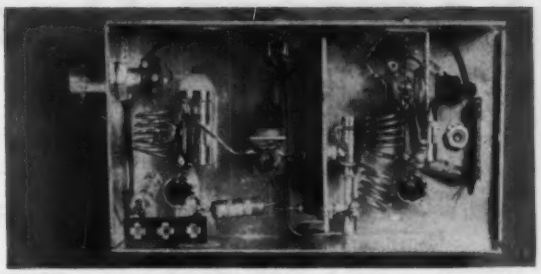


FIG. 1—Oscillator frequency is changed by varying operating point of Q_1. Tuning is done with R_1 and R_2



Frequency stability of transistorized telemetry unit is better than vacuum-tube unit it replaces

Telemeter Transmitter

pedance of the circuit is low.

The antenna used was of the type most often called a coaxial. It is a center-fed dipole with the transmission line fed in through the end of one of the elements. In the balloon apparatus, the antenna was suspended with the thin element pointing down. The radiation pattern was then approximately doughnut shaped and provided the most favorable receiving angle when the balloon was farthest away. No difficulty was experienced with signal nulls. The thin elements were cut from steel drill rod for strength and then given a thin copper plate.

The antenna did not tune sharply. The standing-wave ratio, as measured with an inexpensive reflected power meter, did not exceed 1.3:1 from 90 to 94 mc. Impedance should be approximately 50 ohms. No facilities were immediately available to accurately measure impedance.

Tuning

All tuning is done by substituting potentiometers for R_1 and R_2 in Fig. 1 and inserting an ammeter in each collector circuit. After tuning is completed, the potentiometers are replaced with equivalent fixed resistors. Convenient sizes for the potentiometers are 5,000 and 1,000 ohms for R_1 and R_2, respectively. A dummy load and power meter are connected to the output.

To tune the unit, R_1 is set for an oscillator collector current of about 6 ma. Potentiometer R_2 is set for an amplifier collector current of about 5 ma. The oscillator is set to 92 mc (or the desired frequency) by adjusting C_4. Capacitor C_3 is adjusted for maximum output. Oscillator current is increased to 12 ma and frequency reset. Amplifier current is increased in steps to about 22 ma, and the output stage is retuned at each step.

If the oscillator stops operating when amplifier current is increased, coupling should be decreased by detuning C_3 and by bending away L_2 until the oscillator shows no sign of stopping.

In the units built, C_3 was set near maximum capacitance and no further adjustments made. With 22-ma amplifier collector current, power output should be from 200 to 300 mw. The potentiometers can then be replaced by fixed resistors and the frequency reset. As a final adjustment before installation, the antenna is connected, the complete unit suspended in open air and C_3 is adjusted for maximum reading on a field-strength meter. It is important that the antenna not be handled when the transmitter is on, as the increased load could burn out Q_2.

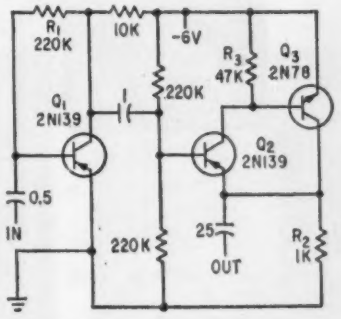


FIG. 2—Modulator has emitter-follower output with close to unity gain

Performance

Eleven units were flown in balloons over Fort Churchill, Manitoba, Canada, in the summer of 1958. Some frequency instability was apparent in the first units flown.

Further experiments were made on the tuning procedure, and, with the method outlined, results were highly satisfactory. Signal strength remained high enough to override considerable local interference even when the balloon was at ranges of about 300 miles. The frequency change over the full day-to-night temperature range was about 0.3 percent.

This work was supported by the U. S. National Committee for IGY under the Technical Panel for Cosmic Rays. Help of the Dukane Corp., which developed a transistorized c-w oscillator, is gratefully acknowledged.

Forming Handwritten-Like

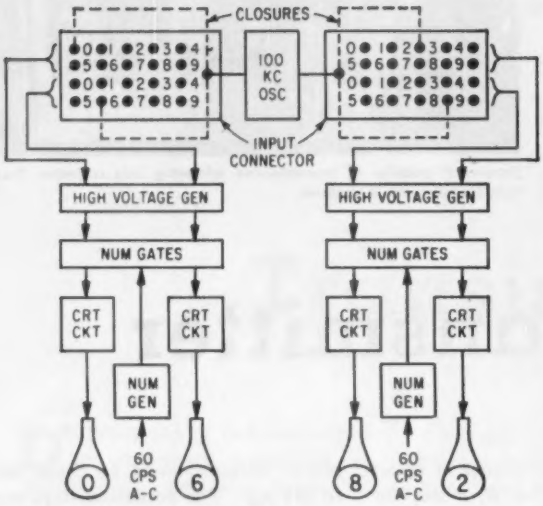
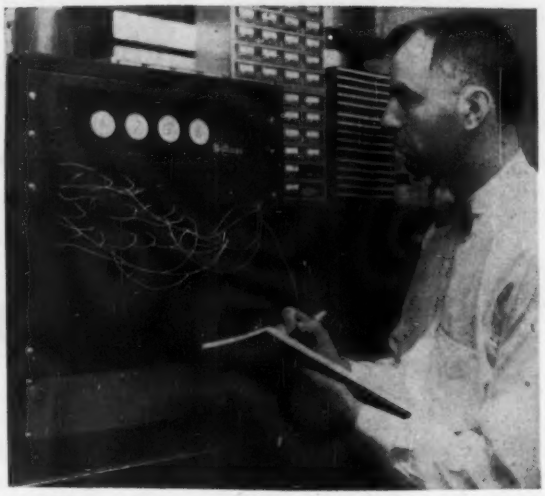


FIG. 1—Four-digit electronic display uses two-inch crts as readout media for each digit



Author records data appearing on display crts. Jumpers simulate closure made by external logic circuit

DIGITAL DISPLAYS associated with computer and instrumentation systems must be readable and reliable. To meet these requirements, the numeric display discussed here was designed to use small cathode-ray tube readout elements to provide good viewing characteristics and passive-circuit number generators to give comparatively troublefree operation.

Display Operation

A block diagram of a four-digit display is shown in Fig. 1. External contact closures are made by pulse amplifiers, decade counters, or other logic circuits. Dotted lines used on the diagram show closures required to produce a 0682 display.

Each external contact closure connects the low-voltage 100-kc signal from the oscillator to a selected high-voltage r-f transformer in the high-voltage generator. Individual transformers are used to handle each number from 0 to 9; there-

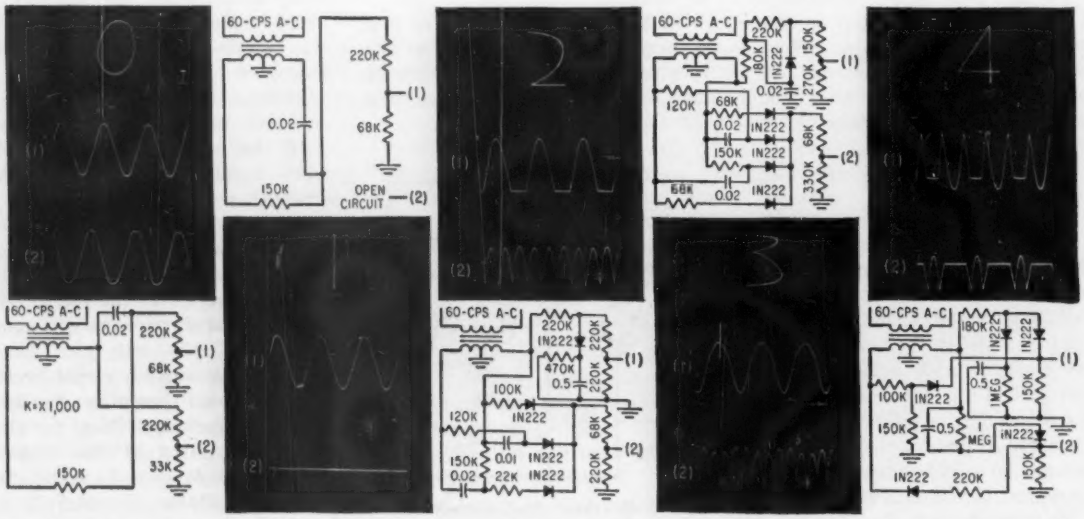


FIG. 2—Number generator circuits used to produce each digit from 0 to 9. Output vertical waveshape (1) and horizontal waveshape wave used for vertical waveshapes for number 1 is taken directly from vertical output of the 0 generator

Digits on CRT Display

By **RICHARD L. WHITE,** Chief Applications Engineer, Semiconductor Division, Hoffman Electronics Corp.

Display converts digital data to four-figure readout using passive information circuits and two-transistor oscillator as high-frequency power source. Number generators produce horizontal and vertical waveshapes representing each digit from 0 to 9. Lissajous patterns on crt form numerals that appear to be handwritten

fore, ten transformers are required for each number channel. The high-voltage r-f output from the selected transformer is then applied to an appropriate pair of number gates.

Vertical and horizontal waveshapes used to produce a number are continuously applied to a pair of number gates. When a number gate pair is excited by a high-voltage r-f transformer, the gates open permitting the waveforms to pass through the gain and focus controls in the crt circuit. The waveforms are then applied to the crt deflection plates creating a Lissajous pattern on the screen which closely resembles a handwritten numeral as in Fig. 2.

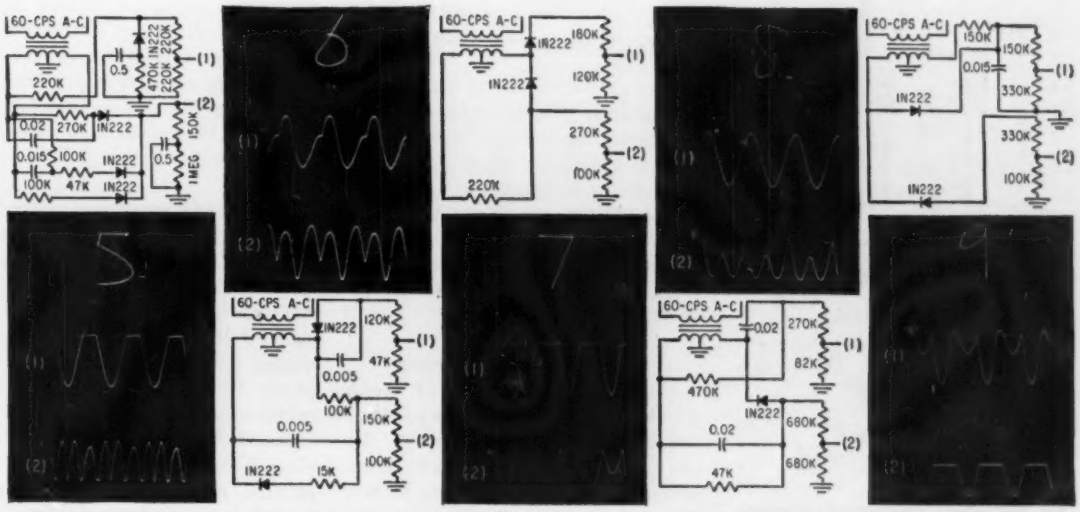
Oscillator

The 100-kc oscillator circuit is shown in Fig. 3. Output voltages are take across the r-f chokes in the collector circuits, thereby enabling the oscillator to engage two digits from each phase. The oscillator circuit is mounted on a printed-circuit board along with its associated low-voltage d-c supply and the high-voltage supplies for the cathode ray tubes.

The high-voltage generator consists of 20 r-f transformers which are tuned to 100-kc. Transformer primaries are excited through a silicon diode by the 100-kc oscillator when the proper external connection is made. A typical transformer circuit is shown in Fig. 4A. The input voltage is a rectangular 5 μsec pulse having a 12-volt amplitude at 40 ma. The output is a sine wave of 100 v rms.

Number Gates

Waveshapes used to form numbers on the cathode ray tubes are continuously applied to the number gates. There are two gates per number; a gate for the vertical



(2) applied to crt deflection plates, and resulting Lissajous pattern are shown on oscillogram above or below circuit. In practice the sine

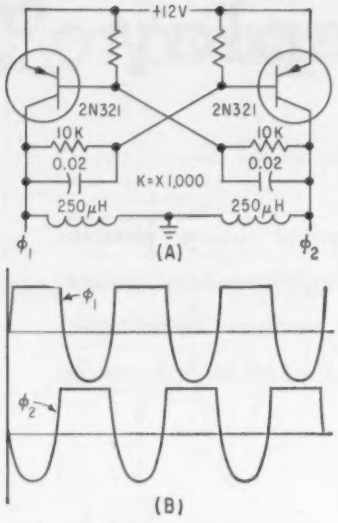


FIG. 3—Typical high-voltage generator (A) and typical number gate (B)

waveshape and a gate for the horizontal waveshape. The twenty gates required to handle the ten number possibilities for each display channel are mounted on one printed-circuit board. A typical number gate circuit is shown below in Fig. 4B.

Number waveshapes are always present at the input to the gates; however, the waveshapes cannot pass through because of the back-to-back diodes in the gate. When the 100-kc from the high-voltage generator is applied to a pair of gates and rectified, the two diodes

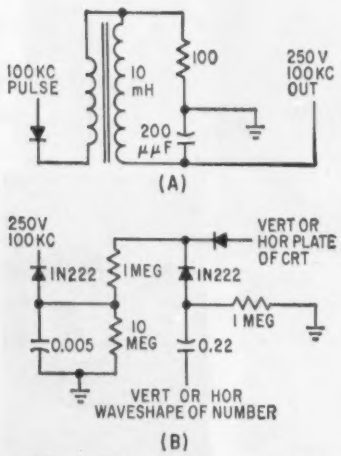


FIG. 4—Oscillator simultaneously energizes all four r-f transformers required for four-digit readout

in each gate are brought into a conducting state. The number waveshapes then pass through the gate to the crt circuit..

Number Generators

The horizontal and vertical wave shapes required to form each number displayed on the crt are produced by the number generator circuits. All waveshapes are derived from a 60-cps, center-tapped, sine wave source.

Reliability is insured through the use of passive elements to generate the necessary waveshapes. Since the generators consist of only resistors, capacitors and silicon diodes, the circuits cannot become faulty or inoperative because of

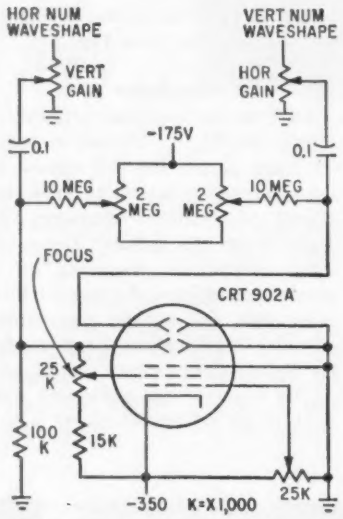


FIG. 5—Typical crt control circuit

changes in gain or other troubles commonly associated with active elements such as vacuum tubes or transistors. Simplicity of the design also contributes to the reliability of the device. All circuits utilize standard techniques of diode clipping, diode limiting and/or phase-shifting.

Waveshaping Circuits

Output waveshapes of each number-generating circuit produce the final Lissajous patterns on the crt. The 0 digit is derived from two sinusoidal waveshapes with a 90-degree phase difference as shown in Fig. 2. Since the number 1 requires only a vertical waveshape, the 0 vertical waveshape can be applied as shown in Fig. 2.

The vertical waveshape for the number 2 is unshifted sine wave with a diode limiter controlling the negative excursion. The horizontal waveshape has three components; two derived from phase shift networks and the other one directly from the 60-cps supply as shown in Fig. 2.

Diode Requirements

Number waveshapes must be generated at the voltage levels required by the deflection plates of a two-inch crt. This operating condition puts a high back voltage on the diodes in the wave-shaping circuit, therefore silicon type 1N222 diodes are used. These diodes also increase the circuit reliability because of their better temperature characteristics and inherent low back current.

CRT Circuits

Four scope circuits identical to the one shown in Fig. 5 are used. One printed-circuit board contains the scope circuits for two crts. Although a two-inch crt is used here, any other size can be employed.

One advantage in using crts is that the viewing angle is quite large and does not have the limitations characteristic of edge lighted panels or horizontally aligned grids.

Since nothing is in front of the number, viewing brightness is constant. In other types of display, a number is viewed through several other number elements. This arrangement results in displays of varying brightness with relatively short viewing distance.

Construction

The entire display unit is composed of printed cards that slide into a U-shaped chassis. All interconnecting wiring is located on the back of the chassis. A smaller U-shaped chassis containing the power transformer and input connectors fits on the back of the main chassis. Although a four-digit display is described, with additional printed circuit boards a display having any number of digits can be constructed.

Iron Powders for Cores

Magnetic iron powder is a basic electronic material. Tables round up typical properties of pressed and sintered cores

THERE ARE some 40 grades of iron powders used as core materials in transformers, tuners, loading coils and other components.

Table I lists some of the principal types of powders and core values reported by manufacturers. Since core manufacturers may form cores with differing insulation, binders and densities, choice of characteristics is wider.

Permeabilities can be raised by coining, annealing or sintering after pressing. Sintering gives the greatest increase. Table II shows some results.

CORE LOSSES—Permeability and core losses are related to particle shape and size. The spherical shape of carbonyl, for example, is believed responsible for its low hysteresis loss. Diameter to permeability and loss ratios are calculated for some materials.

Nickel-iron powders are also used as core materials. The cores may be pressed from alloy powders and annealed[2] or from powders prepared by the reduction of nickel and iron pentacarbonyl[1]. Typical values are given in Table III.—GS

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TABLE II—Effect of Sintering on Iron Powder

	Sinter Temp (°C)	Permeability	Coercive Force (oersted)	B_{sat} (gauss)
Carbonyl	850	2,800	0.33	20,500
	1,050	2,100	0.24	20,500
	1,250	1,750	0.27	20,100
Electrolytic	1,120	1,600	5[a]	8,000
	1,120[b]	2,400	5[a]	12,000

[a] Field strength [b] Annealed after sintering

TABLE III—Typical Properties of Nickel-Iron Cores

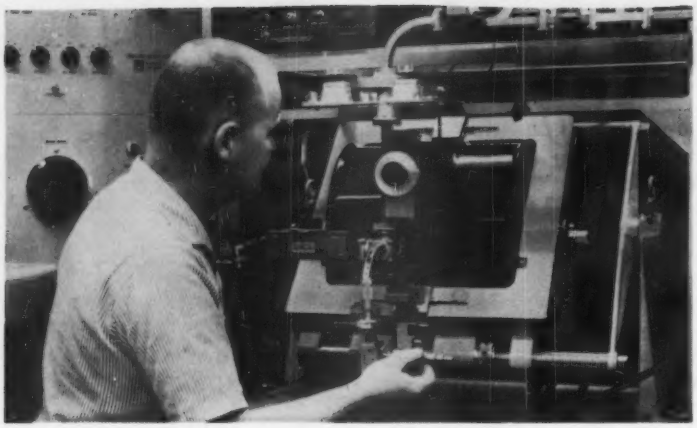
Material	Permeability	Loss Coefficients $(c\times10^6)$	$(e\times10^3)$	$(a\times10^6)$	Use Freq
Molybdenum	125	30	19	1.6	<15 kc
Permalloy	60	50	10	3.2	10–50 kc
	26	96	7.7	6.9	30–75 kc
	14	143	7.1	11.4	50–200 kc
Ni-Fe	10–30	>500	0.4–0.5	10–70	
Carbonyl Sintered	95–100			18–20	

c = residual loss; e = eddy-current loss; a = Hysteresis loss

TABLE I—Properties of Representative Compressed Iron Powder Cores

Material and Trade Names	Average Particle Size (microns)	Apparent Density	Permeability	Typical Core Losses: Eddy cur $(e\times10^6)$	Hysteresis $(a\times10^3)$	Magnetic Stability (percent)	Frequency Generally Used	Relative Q
Carbonyl								
Primary	3–8	2.5–3.5	5–15	0.1–0.11	0.3	0.15–0.6	0.1–100 mc	med-high
High Q	3, 9	2.8–3	4–9		0.35–0.55	0.6–0.7	>20 mc	high
Annealed	10, 20	1.8–3	15–80	0.13–0.14	1.1–3.1	0.6–1.4	0.1–3 mc	med-high
Coated	8	2.5–3	15–100	.....	.....	2.11	0.1–10 mc	high
Reduced	15	2.4–2.8	12–40	0.12	0.1	1.6	0.2–2 mc	medium
	20	2.7–2.8	15–35	0.12	2.9	1.3	0.1–5 mc	medium
	8	1.75–2.15	8–15	0.11	3.1	1.5	2–20 mc	medium
	40	3–3.15	15–35				0.1–0.2 mc	medium
Flakes								
Electrolytic	15–25	6[a]	35	0.33[b]	0.24[b]	−0.17[b]	0.1–1 mc	low
	200–400	6.5[a]	50				60 cps–20 kc	low
Nonelectrolytic	50–75	6[a]	40				10–100 kc	low
	15–25	5.9[a]	30				0.1–1 mc	low
Iron Oxides	8	3.5[a]	2.5–4.5	0.085	0.3	0.1	20–200 mc	high
		4.1[a]	7.9	11.5	9.1	−2.1	0.2–4 mc	medium
		4[a]	5.7	0.21	6.8	−1.6	5–200 mc	high

[a] Core density [b] Core with permeability of 23.4 and density of 5.6



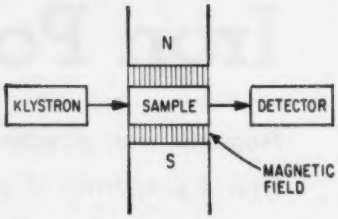


FIG. 1—Basic equipment for the measurement of electron resonance

Microwave equipment and magnet shown here constitute the heart of the microwave electron resonance spectrometer. Sample in cavity is located between magnet windings

Microwave Spectrometer

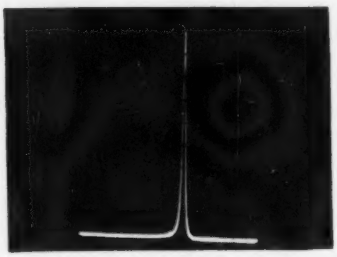
KNOWLEDGE of the energy levels in paramagnetic substances is required to understand and design newly practical devices like the solid-state maser.[1, 2, 3] In masers, populations of the energy levels in paramagnetic samples are redistributed by pumping to obtain amplification at certain frequencies. Hence, knowledge of the absorption properties of these paramagnetic samples is required before one can determine what materials are suitable.

Paramagnetic materials have permanent magnetic dipoles which are oriented at random in the absence of external magnetic fields. These permanent magnetic dipoles arise from the angular momentum of the electrons of the material. The spinning charges give rise to a magnetic field. Generally the angular momentum is derived from the uncompensated spins of the electrons in the paramagnetic substance. The value of magnetic susceptibility for paramagnetic substances is small and positive. Examples of such substances are materials containing atoms with unfilled shells such as titanium, vanadium, chromium and manganese. The resonance observable in these materials is referred to as electron resonance or paramagnetic resonance. It was first discovered in Russia,[4] but most of the research has been done in England[5] and the United States.

Basic Principle

The basic principle of electron resonance is illustrated in Fig. 1. A paramagnetic substance is immersed in an external d-c magnetic field and an oscillating r-f field from the klystron. The d-c magnetic field is varied slowly and linearly as a function of time. At a certain value of magnetic field H, energy from the klystron source is absorbed by the sample. The value of H in gauss is determined by the relation $H = hf/g\beta$, where h is Planck's constant, f is the klystron frequency in cps, g is a dimensionless factor called the spectroscopic splitting factor and β is a constant called the Bohr magneton.

In practice the simple system of Fig. 1 must be augmented by additional refinements. A resonance cavity is used to increase the microwave magnetic field amplitude because the mechanism of energy transfer from the oscillating electromagnetic field to the sample is by way of the r-f magnetic field. Low-frequency sinusoidal modulation of the magnetic field, H, is used so that, near resonance, the sample is taken in and out of resonance at a known frequency and with a known time relation (phase).



Oscillogram of electron resonance absorption line observed in stable EE radical diphenyl picryl hydrazyl, an organic salt

Modulation of the microwave carrier results in an increase in the signal-to-noise ratio by decreasing the bandwidth required of the amplifier after microwave detection. Hence, narrow-band amplification and phase detection can be used. Integration by connecting various R-C networks across the recorder also increases the S/N ratio. This necessitates a slow magnetic field sweep, but observation time is traded for S/N improvement.

A magic T or microwave bridge measures small changes in the Q of the sample-loaded cavity as the magnetic field is swept through resonance. By balancing the bridge at some static H field not at sample resonance, the sample can be immersed in a large microwave field without the detecting crystal being subjected to large microwave power

Electron resonance phenomenon in paramagnetic materials has significance in selection of suitable salts for maser applications and for the study of solid-state structure. This device supplies a magnetic field which is swept linearly with time for use in absorption test methods

By **R. R. UNTERBERGER,** California Research Corporation, La Habra, Calif.

Tests Electron Resonance

with ensuing high values of low-frequency noise. An afc system keeps the klystron on the resonant frequency of the sample-loaded cavity. Equipment to measure accurately the microwave frequencies at which both electron resonance and nuclear (proton) magnetic resonance take place is also required. Proton resonance is used to measure H precisely. To avoid power saturation of the sample, power entering the magic-T arm containing the sample must be monitored.

A complete block diagram incorporating the above features is shown in Fig. 2.

Operation

The paramagnetic sample to be investigated is placed in a hole in the rectangular resonant cavity. If the material is a solid it may be inserted directly. If a liquid, it can be inserted in a small sample tube designed to fit the opening in the cavity. Both methods have been used successfully. The rectangular cavity is resonant in the TE_{102} mode.

The cavity provides a sample position for the observation of electron resonance where the microwave E field is essentially zero, and where the microwave H field is a maximum and has a direction colinear with the axis of the sample.

The cavity is oriented so that this direction is perpendicular to the static external magnetic field H to maximize the spin transition probability. Energy is transferred from the microwave magnetic field to the

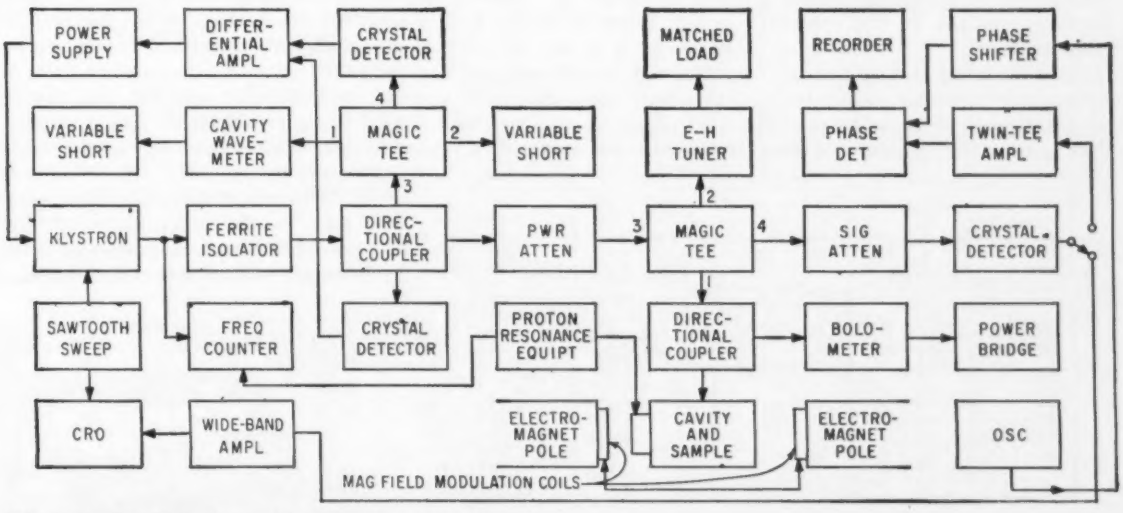


FIG. 2—Complete block diagram of microwave spectrometer system

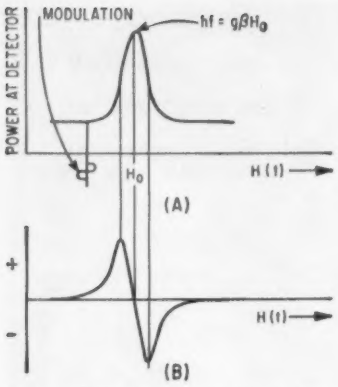


FIG. 3—Absorption phenomenon at electron resonance as it appear on scope (A) and after slope detection, on recorder (B)

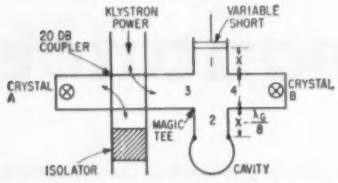


FIG. 4—Automatic-frequency-control system for klystron oscillator

paramagnetic sample by magnetic coupling to the quantum mechanical spin orientations possible in the magnetic substance. On a classical basis the electron can be considered as a gyroscope precessing about the direction of the external magnetic field. The torque exerted by the microwave magnetic field acts in such a manner as to flip the spin over. This means that the spin of the electron goes from a position whereby it is precessing about a direction opposed to the external magnetic field.

Since the latter case is quantum-mechanically a higher energy state, energy is required in the process of flipping over the spins of the electrons. This gives rise to an energy absorption from the microwave field in accordance with $hf = g\beta H$.

Energy absorbed by the paramagnetic sample is measured physically by observing variation in the Q of the resonant cavity as the magnetic field is swept. When electron resonance occurs, microwave energy is absorbed by the sample and is converted into heat. The reflection coefficient of the cavity is changed by this absorption of energy. Hence, reflection from the opposite arm of the magic T of Fig. 2 does not cancel the reflection from the resonant cavity at this value of H. A change in microwave power level occurs at the crystal detector.

Riding on the microwave carrier wave is a low-frequency signal of about 100 cps caused by modulation of the magentic field. This technique takes the sample in and out of resonance, thereby amplitude modulating the reflection coefficient. Because modulation is carried out at a known frequency and phase relationship, a narrow band amplifying system can be used. Resonance is observed by slope detection as shown in Fig. 3. A recorder plots the derivative of the absorption peak occurring at electron resonance of the paramagnetic sample.

Automatic Frequency Control

As shown in Fig. 4, klystron microwave power coming down the waveguide and into the 20-db coupler is tapped off the main guide into the magic T, where it enters arm 3. Power is equally divided between arms 1 and 2 with equal phase and travels outward toward the cavity and the short circuit. At frequencies far removed from resonance, the cavity is positioned so that it appears like a short circuit ¼ wavelength closer to the magic T than the short circuit on the opposite arm. The reflected waves in the two arms reconverge on the junction with a relative phase of 90 deg because the wave in arm 1 of the magic T has traveled $\lambda g/4$ times farther than the wave in arm 2. Waves of equal amplitude but of opposite phase are coupled out of arms 1 and 2 into arms 3 and 4 where they are detected by crystals *a* and *b* respectively. The isolator absorbs reflections from the main waveguide.

At resonance, the cavity represents a conductance either larger or smaller than the characteristic admittance of the waveguide. The resultant voltages at the two crystals are equal in amplitude. At frequencies close to resonance, the reflection coefficient of the cavity is either advanced or retarded in phase relative to that at resonance. On one side of resonance, the power delivered to arm 4 of the magic T is greater than that returned to crystal *a* through arm 3. On the other side of resonance, arm 3 receives the greater power. The difference between the voltages rectified by the two crystals is therefore a function of frequency similar to the output voltage of the conventional discriminator circuit. This d-c signal is amplified by the direct-coupled differential input amplifier. Its output is in series with the klystron reflector voltage. Experiments have shown that an error voltage (noise) on the klystron of sufficient magnitude to change its frequency by 1 mc causes a drift of only 400 cps with this afc circuit. amplifier shown in Fig. 5 is patterned after one used in microwave spectroscopy[6].

The help of J. L. Garcia de Quevedo in the construction of this equipment and in particular with the afc system, is acknowledged.

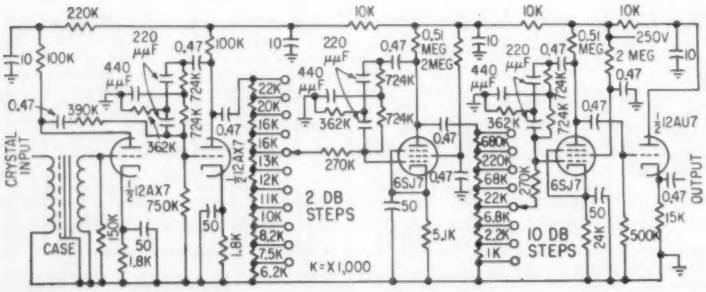


FIG. 5—Twin-T amplifier used on output of crystal detector

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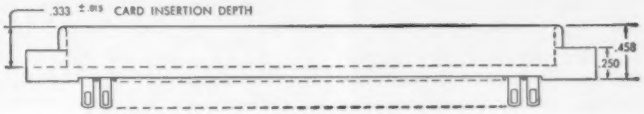
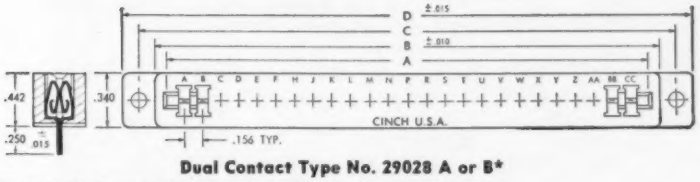
A polarizing contact made of brass, Sel-Rex gold plated, can be placed in any contact position. Insulation material is of glass filled Diallyl Phthalate (Type GDI-30 per Mil. M-19833). Contacts are of Beryllium Copper or Phosphor Bronze with Sel-Rex gold plate .00003 Minimum. Terminals are mounted on .156" centers. Mounting holes are .128" dia.





Dual Contact Type No. 29028 A or B*

Made in 12 through 50 contacts in multiples of two. Designed for nominal 1/16" printed wire board, copper clad on both sides.

Contacts, polarizing contact, insulation and mounting holes are the same as described for No. 29029.

*A—Phosphor Bronze Contact *B—Beryllium Copper Contact

Insulation is among the best available from both electrical and mechanical standpoints.

Contacts are especially designed for minimum printed circuit card wear, low insertion force and positive contact with the printed wire board.

The lack of sharp radii in the contact design makes it possible to offer this contact in either Beryllium copper or Phosphor Bronze. Due to the use of heavier material in the contacts the tails are more rigid than those in similar connectors that are presently available.

	AC RMS	DC
VOLTAGE BREAKDOWN:		
Sea level (adj. terminals)	2500	3800
Altitude 3.4 HG. 50,000 ft. (adj. terminals)	900	1200
Altitude 1.3 HG. 70,000 ft. (adj. terminals)	600	850
VOLTAGE RATINGS:		
Sea level (adj. terminals)	830	1270
Altitude 3.4 HG. 50,000 ft. (adj. terminals)	300	400
Altitude 1.3 HG. 70,000 ft. (adj. terminals)	200	280
RECOMMENDED WITHSTANDING VOLTAGE:		
Sea level (adj. terminals)	1870	2850
Altitude 3.4 HG. 50,000 ft. (adj. terminals)	675	900
Altitude 1.3 HG. 70,000 ft. (adj. terminals)	450	640

Current Rating 10 Amperes

Contact resistance at 7.5 amperes measured with nominal thickness printed wire board.	0.0027 Ohms Max.
Insulation resistance	5000 Megohms Min.
Insulation resistance (immediately after 96 hours at 90-95% R.H. and 40°±2° per method 103A of Mil-STD-202A	100 Megohms Min.

In ordering use base number, 29029 or 29028, followed by the number of contacts, then contact material and then the letter indicating position of the polarizing contact. For example 29029-12-A-E, or 29028-16-B-E.

Contact tail as shown available now, wire wrap and dip solder type contacts in the near future.

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; LaPuente, California; St. Louis, Missouri

Single Contact Type No. 29029

BASE NO.	NUMBER OF CONTACTS	DIMENSIONS A	B	C	D
29029	6	1.098	1.239	1.531	1.785
29029	7	1.254	1.395	1.687	1.941
29029	8	1.411	1.552	1.844	2.098
29029	9	1.567	1.708	2.000	2.254
29029	10	1.723	1.864	2.156	2.410
29029	11	1.879	2.020	2.312	2.566
29029	12	2.036	2.177	2.469	2.723
29029	13	2.198	2.333	2.625	2.879
29029	14	2.348	2.489	2.781	3.035
29029	15	2.504	2.645	2.937	3.191
29029	16	2.661	2.802	3.094	3.348
29029	17	2.817	2.958	3.250	3.504
29029	18	2.973	3.114	3.406	3.660
29029	19	3.129	3.270	3.562	3.816
29029	20	3.286	3.427	3.719	3.973
29029	21	3.442	3.583	3.875	4.129
29029	22	3.598	3.739	4.031	4.285
29029	23	3.754	3.895	4.187	4.441
29029	24	3.911	4.052	4.344	4.598
29029	25	4.067	4.208	4.500	4.754

Dual Contact Type No. 29028

BASE NO.	NUMBER OF CONTACTS	DIMENSIONS A	B	C	D
29028	12	1.098	1.239	1.531	1.785
29028	14	1.254	1.395	1.687	1.941
29028	16	1.411	1.552	1.844	2.098
29028	18	1.567	1.708	2.000	2.254
29028	20	1.723	1.864	2.156	2.410
29028	22	1.879	2.020	2.312	2.566
29028	24	2.036	2.177	2.469	2.723
29028	26	2.192	2.333	2.625	2.879
29028	28	2.348	2.489	2.781	3.035
29028	30	2.504	2.645	2.937	3.191
29028	32	2.661	2.802	3.094	3.348
29028	34	2.817	2.958	3.250	3.504
29028	36	2.973	3.114	3.406	3.660
29028	38	3.129	3.270	3.562	3.816
29028	40	3.286	3.427	3.719	3.973
29028	42	3.442	3.583	3.875	4.129
29028	44	3.598	3.739	4.031	4.285
29028	46	3.754	3.895	4.187	4.441
29028	48	3.911	4.052	4.344	4.598
29028	50	4.067	4.208	4.500	4.754

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VISIT BOOTH NO. 2535 AT THE I.R.E. SHOW

Radar Booster Charts

Radar augmenter gain and power nomographs find parameters for traveling-wave-tube amplifiers used to increase radar cross section of target drones

By **BENJAMIN P. BAYER,** Radioplane, A Division of Northrop Aircraft, Inc., Van Nuys, California

TRAVELING WAVE TUBES are finding increased use as broadband, high-gain amplifiers for increasing the apparent radar cross-section of light weight target drones or small aircraft. This type of augmentation system does not require repeated tuning of the radar system as in beacon operation, since the traveling wave tubes are capable of operating over full octave bandwidths.

Use

The traveling-wave-tube amplifier type augmenters are required for use with bistatic systems where there is a relatively large separation between the locations of the radar transmitter station and the radar receiving

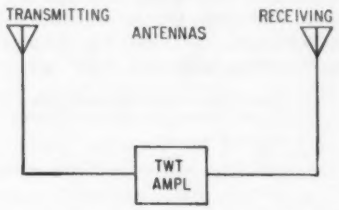
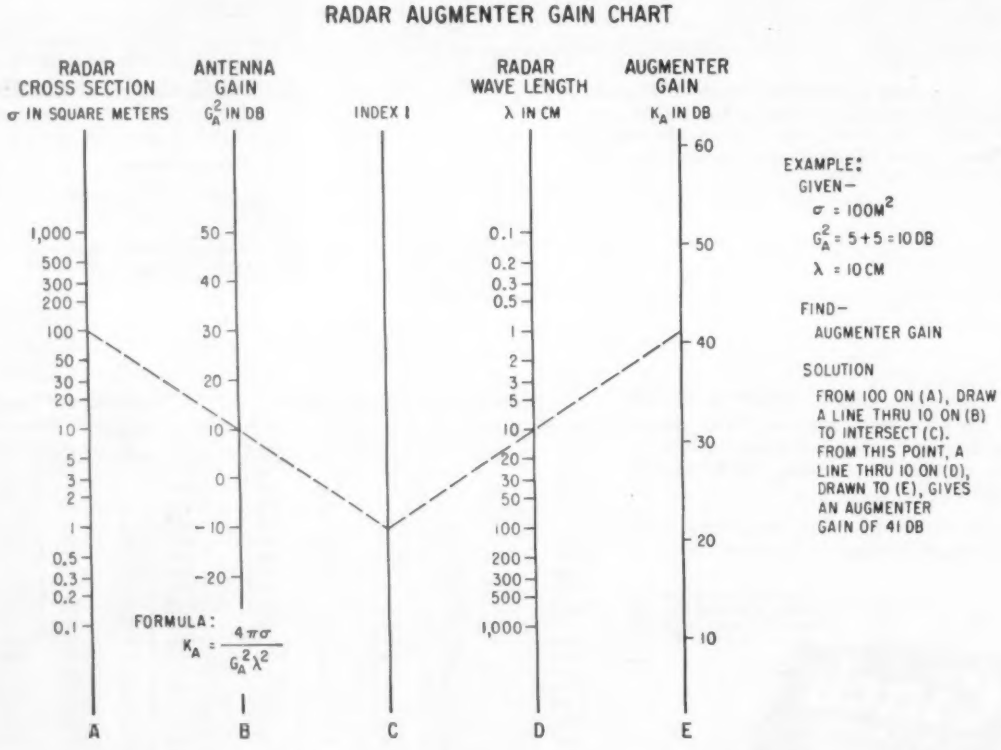
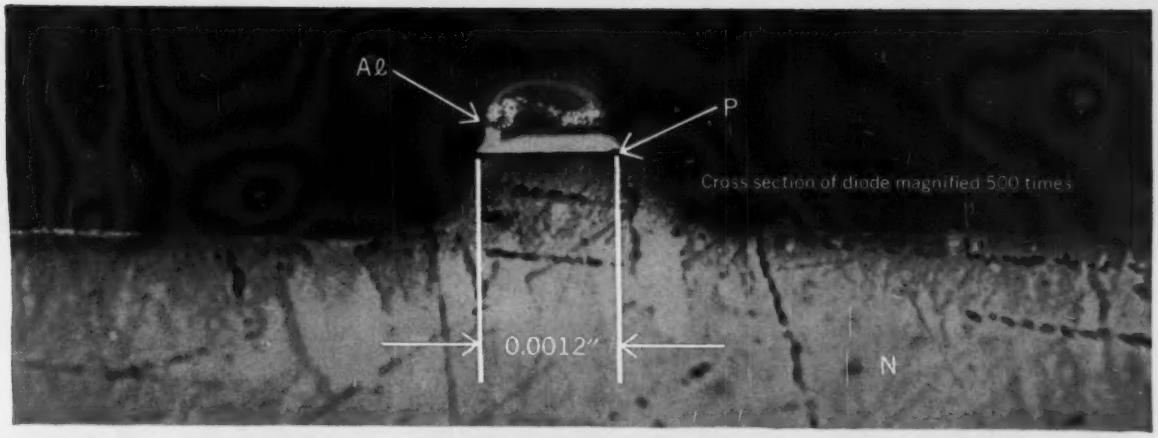
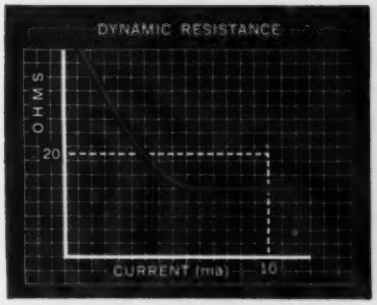
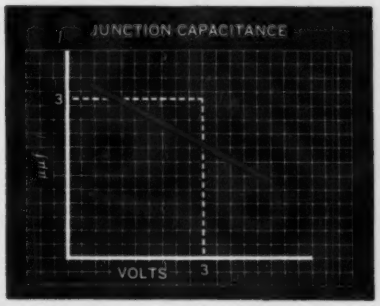


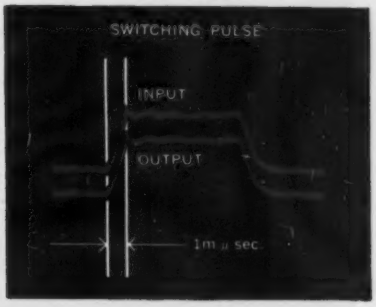
FIG. 1—Block diagram of radar active augmenter system











NEW "AVALANCHE" DIODE SWITCHES IN LESS THAN 0.15 MILLIMICROSECOND

Low Capacitance—Low Dynamic Resistance

Fastest switching device known to science is a new Sperry Semiconductor diode, developed in collaboration with the Univac Division. Observations indicate this diode turns on a current pulse in less than 0.15 millimicrosecond. While calculations indicate even faster response is possible, measurement is limited by the rise time of present-day pulse generators.

Full significance of this Sperry achievement in the art of solid state switching is still to be explored. Immediate applications seen for the design engineer include advanced computers capable of processing data in three days that today takes a year . . . experimental UHF, TV and microwave circuitry . . . navigation and guidance systems for missiles and space vehicles. Prime feature of this device is that its low dynamic resistance and capacitance do not limit its switching time.

The device, packaged as a subminiature glass diode, is designed to operate around the breakdown voltage of an alloyed P-N junction utilizing the avalanche breakdown effect for switching. The P-N junction is formed by alloying a microscopically small (.0015" diameter) aluminum dot onto an N type silicon wafer. This aluminum dot is biased negatively with respect to the silicon wafer near the breakdown voltage. A sudden increase or pulse on this negative voltage causes a current to flow by an "avalanche" mechanism in which one electron will cause many, many more electrons and holes to flow.

Designed for volume production, this new diode is available in limited numbers for experimental use. Write for more information.

Visit our booth 1410-1416, 1959 Radio Engineering Show, March 23-26.

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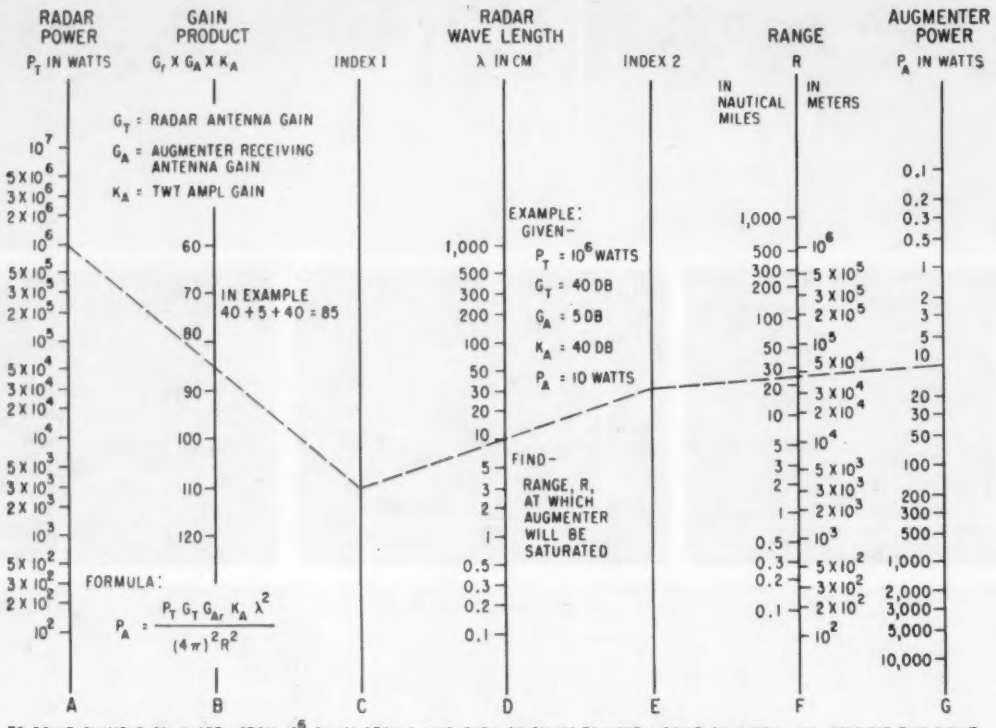
RADAR AUGMENTER POWER-OUTPUT CHART



TO SOLVE EXAMPLE ON CHART- FROM 10^6 ON (A) DRAW A LINE THRU 85 ON (B) TO MEET A POINT ON INDEX 1 (C). CONNECT THIS POINT WITH A LINE TO 10 ON (D), CONTINUING TO INDEX 2 (E). FINALLY DRAW A LINE FROM THIS POINT ON (E) TO 10 ON (G). THE POINT OF INTERSECTION ON (F) GIVES THE RANGE AT WHICH THE AUGMENTER WILL BECOME SATURATED: 4.5×10^4 METERS OR 24.3 NAUTICAL MILES.

station, thereby requiring a large angle between incident and reflected energy for proper radar system operation.

Retransmission

Antennas used with active augmenters permit retransmission of the radar pulse over wide areas, a feature not possible with corner reflectors or other passive reflector devices which do not disperse, but concentrate, the reflected radar energy. In this type of system, shown in Fig. 1, it should be noted that the transmitting antenna must be isolated from the receiving antenna for r-f signals by a factor which must be greater than the gain of the augmenter at any frequency to prevent regeneration.

The accompanying charts provide a ready method for determining the gain and power requirements for design of an active radar augmenter.

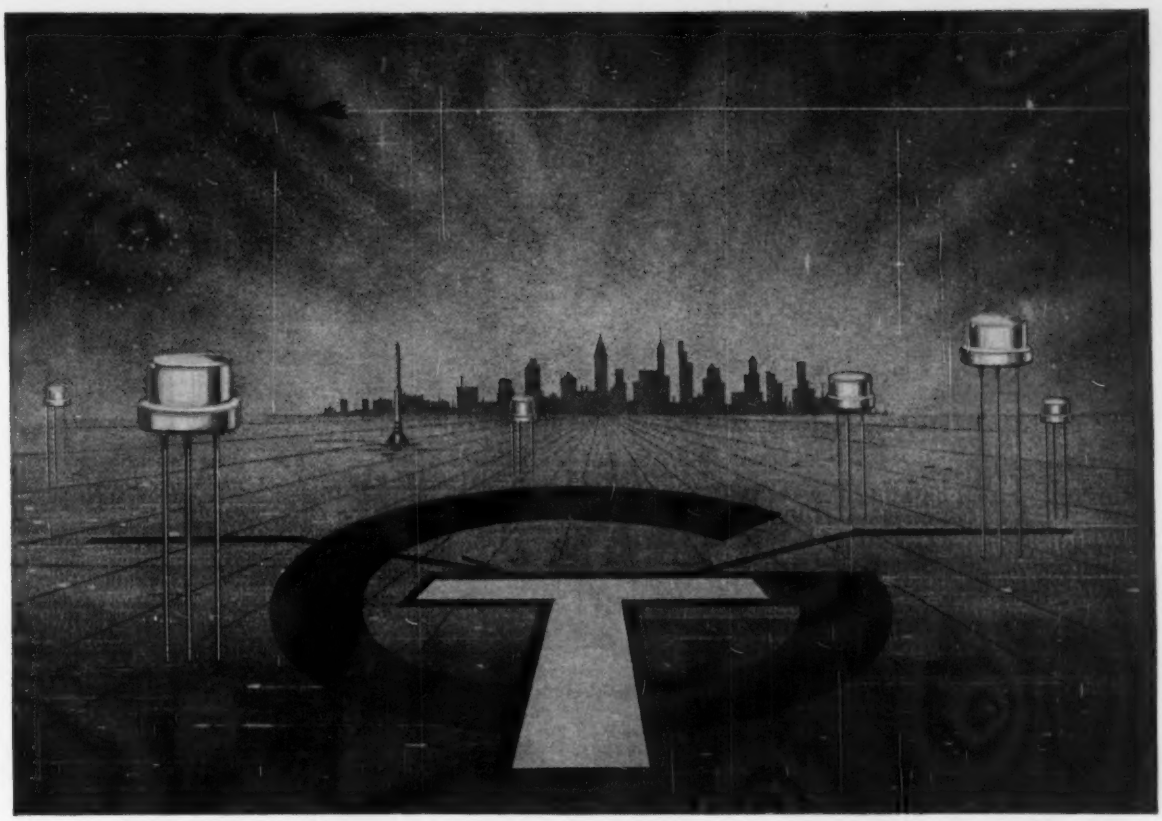
Augmenter gain is determined by the target size, the frequency coverage and the angular coverage required—which will limit the antenna gains attainable. The value of the traveling-wave-tube amplifier gain is given by the formula on the augmenter gain chart. An example is given and solved on the chart.

Power Output

A traveling-wave-tube augmenter will stimulate the required target reflectivity into a range where the tube reaches saturation. At this point, any increase in input power will not produce an increase in output power. In fact, beyond saturation, a drop off in power will be evident. The radar augmenter maximum power output required to provide simulation into a specified range is given by the formula on the power output nomograph. An example is given and solved on the chart.

Other Factors

These nomographs are theoretical, and for more precise calculations, other factors such as transmission line losses should be included. However these losses can be subtracted from the gain figures. The user would then obtain effective values of G_T, G_A and K_A.



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DC Current Gain h_{FE}			Gain X Bandwidth		Power Gain K_p		
2N602 2N603 2N604	$V_{CE} = 1$ v $I_B = 0.5$ ma	* 25-100	$V_{CB} = 5$ v $I_C = 5$ ma	10-30 mc 30-50 50-70	2N605 2N606 2N607 2N608	$V_{CB} = 7.5$ v $I_C = 1$ ma $f = 2$ mc	20-25 db 25-30 db 30-35 db 35-40 db

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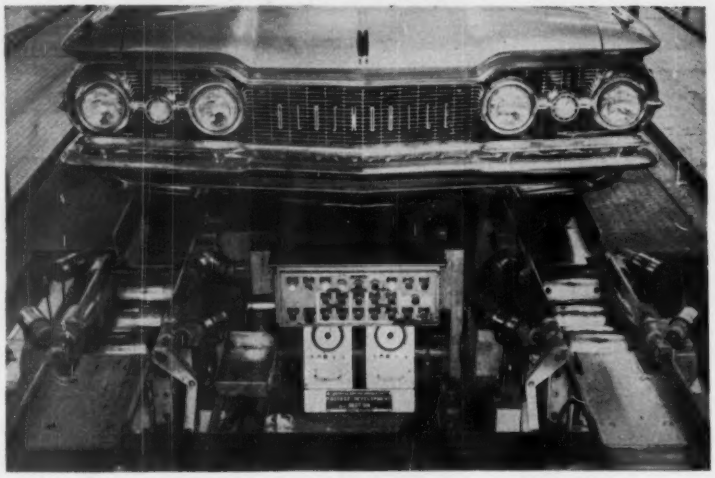
Instrument Checks Wheel Toe-In

ELECTRONIC instrument has been developed to indicate correctness of automobile toe-in adjustments. The device is now in use at Oldsmobile division of GM.

The toe-in indicators present a meter indication of toe-in for the operator of the toe-in setting machine. The information is also recorded for use in quality control.

A signal proportional to toe-in error of one wheel is supplied by a transducer mounted on the rotating head of the toe-in setting machine. The a-c signal is demodulated, and amplitude of the d-c output is proportional to error. Polarity indicates direction from desired setting. The recorder is provided with a scale to convert the reading to inches.



Electronic equipment makes further inroads in automobile manufacture in the form of an electronic toe-in indicator

The transducer, made by Crescent Engineering, has a center-tapped coil, each half of which forms one leg of a bridge. An iron core concentric to the coil is actuated by the movable head assembly of the machine. Core position determines how much of the 60-cycle bridge-energizing voltage appears across each half of the coil.

The other two bridge legs are formed by a ten-turn potentiometer in the toe-in indicator unit.

The 60-cps signal from the bridge is either in phase with the energizing voltage or 180 degrees out of phase, depending on which side of the center tap the core is located. For correct toe-in, the core is at the center tap, and bridge output is zero.

The signal derived from the bridge is applied push-pull to the grids of a twin triode. Plate voltage is 250 volts, 60 cycles and is furnished by a winding on the same transformer that energizes the bridge. Plate voltage is therefore either in phase or 180 degrees out of phase with signal voltage. Thus, the amplifier provides phase-sensitive detection of the toe-in error. Large capacitors across the plate load resistors filter the output.

A portion of the bridge energizing voltage is tapped to provide a calibration voltage for adjusting amplifier gain. Zero adjustment is done by controlling the amount of plate voltage going to each half of the amplifier. With zero signal in, quiescent current in the two tube halves is balanced.

Feedback Increases Input Impedance

USING NEGATIVE feedback, voltage gain in a transistor amplifier can be exchanged for input impedance. Also, voltage gain is made more independent of transistor parameters.

A transistor amplifier has been developed by Texas Instruments using TI 2N338 silicon transistors that has an input impedance of 8 megohms. Voltage gain is 40 db and output impedance is 600 ohms. Gain is stable to ±0.1 db over the temperature range from −55 to 125 C and within ±1 db from 6 cps to 300 kc. Input impedance is greater than 1 megohm between 25 cps and 30 kc.

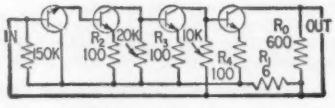


FIG. 1—Simplified circuit shows how negative feedback can be used to increase input impedance of transistor amplifier

The amplifier consists of a common-collector stage followed by three common-emitter stages. High input impedance and gain stability are achieved in the amplifier circuit in Fig. 1 by overall negative feedback provided by resistor R_1. Resistors R_2, R_3 and R_4 are individual stage feedback resistors. This simplified circuit is valid for midfrequency range where reactances of bypass and coupling capacitors may be neglected.

Voltage drop across R_1 is in phase with input voltage. A-c current through R_1 is approximately equal to the product of input current and current gain of the individual amplifier stages.

If amplifier current gain is 10^6 and R_1 is 6 ohms, the equivalent

Stamp on top of bulb clearly shows date Bell Laboratories installed Tung-Sol/Chatham 5R4WGY rectifier tubes. September 9, 1958, five years, over 43,000 hours later, the tubes were removed.

Tung-Sol/Chatham tubes operate 43,000 hours — more than five years

Bell Laboratories, Murray Hill, New Jersey — research and development center for new and better telephone components — recently removed two Tung-Sol/Chatham 5R4WGY rectifier tubes, forerunner of the improved 5R4WGB, after more than five years of unbroken, high-quality operation.

Records revealed that on March 20, 1953, Bell Laboratories installed the rectifier tubes in a frequency distribution amplifier operated at Murray Hill. Removal date: September 9, 1958, more than five years and 43,000 service hours later. Comparison with the normal 5R4WGY warranty of 500 hours underscores the extraordinary performance of these Tung-Sol/Chatham tubes.

More and more tube users in all areas of industry are gaining similar benefits of long-life reliability found throughout Tung-Sol/Chatham tubes. You can too! When you need replacements . . . the next time you order new electronic equipment, specify Tung-Sol/Chatham tubes! For further information, to fill a special socket, contact: Chatham Electronics, Division of Tung-Sol Electric Inc., Newark 4, New Jersey.

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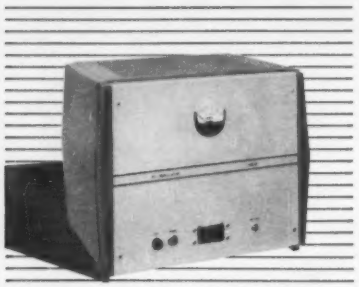

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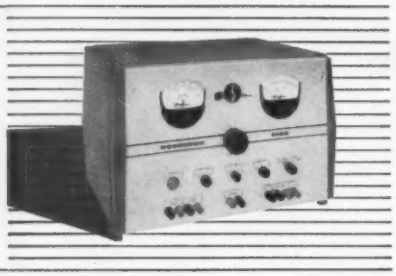

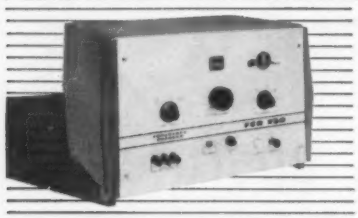

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Model R5010 Tubeless AC Line Regulator (top)
Model 610B Nobatron DC Supply (center)
Model FCR 250 Frequency Changer (bottom)

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value of R_1 referred to the input terminals is 6 megohms. Approximate input impedance is $Z_{in} = |A|\ R_1 - Z_1$, where A is current gain and Z_1 is input impedance without feedback.

Voltage gain is $V_o/V_{in} = -|A|\ R_o/(|A|\ R_1 - Z_1)$. If $|A|\ R_1$ is much greater than Z_1, $V_o/V_{in} = -R_o/R_1$. The negative sign indicates that output voltage is 180 degrees out of phase with input voltage.

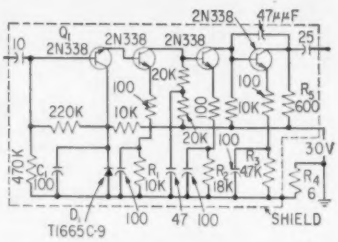


FIG. 2—Mounting components on aluminum sheet insulated from main chassis and connected to ungrounded end of R_4 improved high-frequency performance

The complete amplifier circuit is shown in Fig. 2. The four stages are direct-coupled. Adequate stability of bias conditions is provided by the large emitter resistors R_1, R_2 and R_3, which are bypassed for signal frequencies. Bias voltage for the first stage is developed across the 9-volt Zener diode, D_1. The collector of Q_1 is coupled to feedback resistor R_4 by C_1 and D_1. If this collector were bypassed to ground, input impedance would be shunted by the h_{ob} of this unit.

Output impedance is set by R_5, which is 600 ohms. Input impedance is approximately equal to the product of the amplifier current gain and feedback resistor R_4. Since current gain is a function of transistor parameters, input impedance can be expected to be a function of ambient temperature.

Voltage gain is largely determined by the ratio of output resistor R_5 to feedback resistor R_4 and is almost independent of transistor parameters. Therefore it should not be sensitive to ambient temperature variations.

Noise level of the amplifier will be a function of the input termination. Equivalent input noise will range from about 25 μv with the input shorted to about 450 μv with

the input circuit opened up.

Careful consideration should be given to the layout of the amplifier, particularly with respect to stray capacitance to ground. In the breadboard model, all components were mounted on a 2 by 4 in. sheet of aluminum which was insulated from the main chassis and electrically connected to the ungrounded side of feedback resistor R_f. This greatly improved high-frequency characteristics by reducing the effect of stray capacitance between the components and ground.

Tv Transmitter for Missiles

BATTERY-POWERED tv system has been developed by Lockheed for space applications. First units have been delivered to the Army Ballistic Missile Agency. Lockheed pointed out that the tv system was not developed for any satellite program.

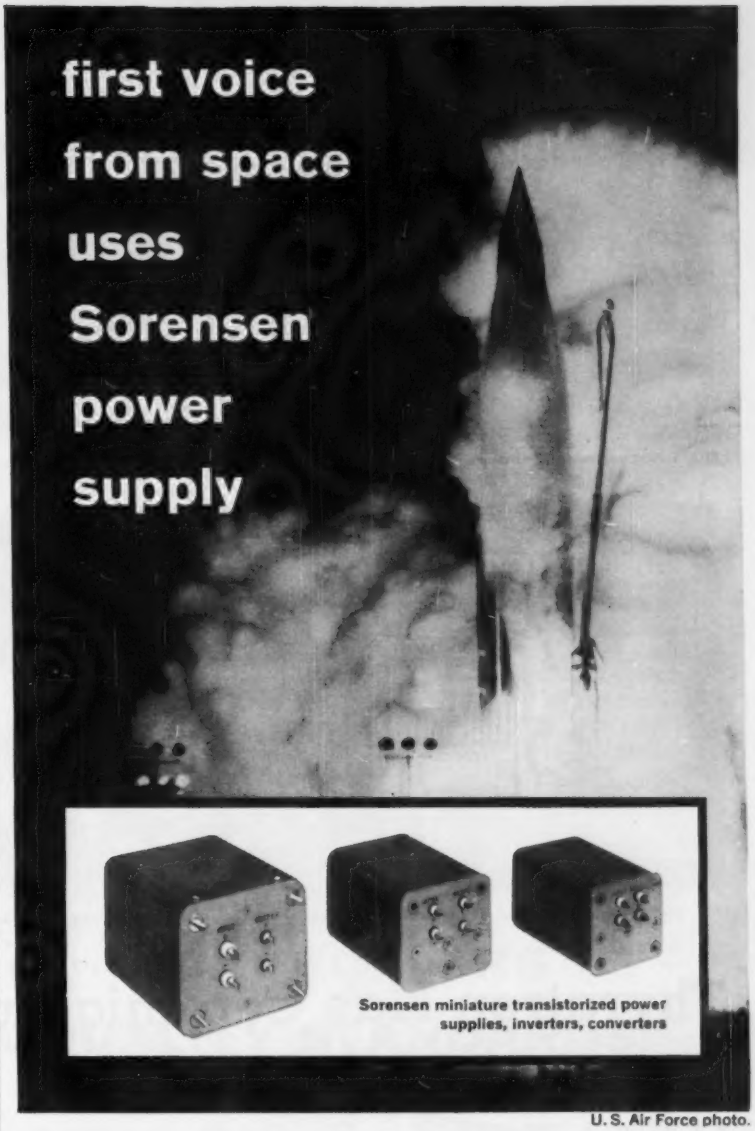
The system, consisting of a camera and three small units, has a 1,000-mile transmitting range. Picture resolution is 500 lines.

The camera itself is 7¾ inches long and 2¼ inches in diameter, and it weighs 42 ounces, including lens. Besides the camera, the system includes a fully transistorized control unit that supplies all necessary sweep and synchronizing signals to the camera. A 14-ounce unit contains the camera controls, and a 47-ounce package houses the 50-watt f-m transmitter.

The system withstands 40 g's of shock, 50 g's of acceleration and 10 g's of vibration.

Applications may include observing missile performance after the missile has disappeared from the sight of ground observers. Critical factors such as stage separation or engine firing could be watched. Passengers in spacecraft could be observed during takeoff or other times when environmental factors might be critical.

Possible commercial uses include aerial navigation, meteorology, oceanography, railroading, observing radioactive or similar contaminated areas and law enforcement. The system might also be used for television news coverage.



U. S. Air Force photo.

Last December, a Christmas message from outer space heralded a new era in radio communications.

Coming from an orbiting, 80-foot-long U. S. Air Force **Atlas** missile, the voice was broadcast over U. S. Army Signal Corps designed communications equipment. We at Sorensen, are proud indeed that a miniature Sorensen transistorized power supply was selected as part of this communications equipment.

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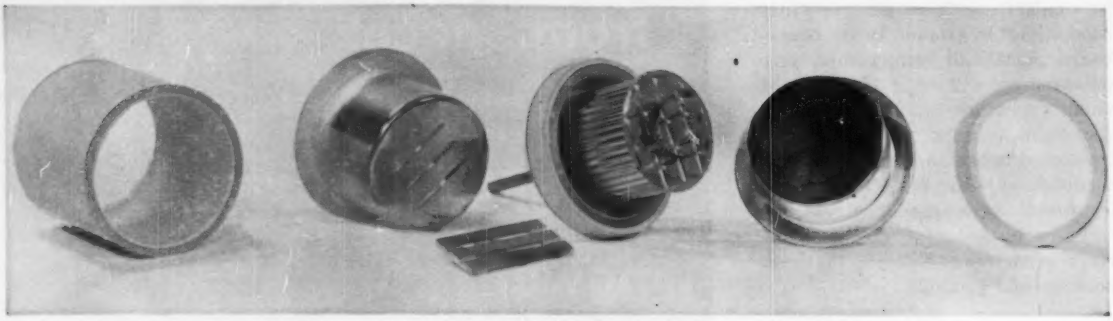

FIG. 1—The ceramic thyratron subassemblies consisting of the envelope, grid cup, cathode unit, anode cup and backing ring

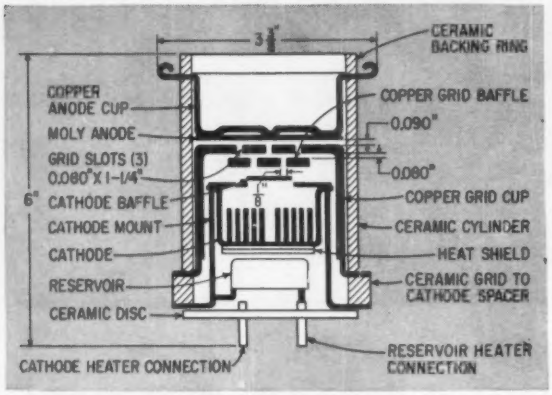

FIG. 2—Cross-sectional view of internal tube structure

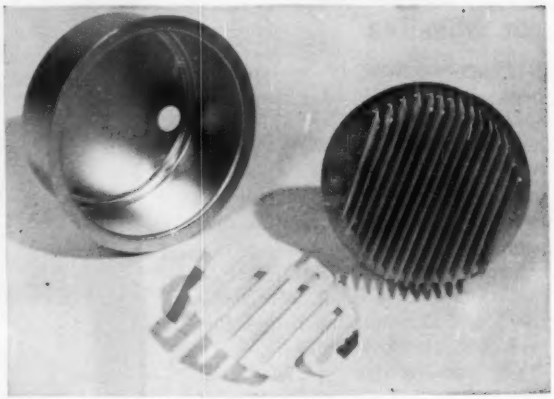

FIG. 3—Cathode with heater and heat shield

Thyratron Has Ceramic Envelope

By DANIEL F. RILEY, Edgerton, Germeshausen and Grier, Inc., Boston, Mass.

ONLY 5¾-in. long and 3⅝-in. in diameter, the 7322/1802 hydrogen thyratron is a ceramic-metal envelope tube for operation at high power, high prr and high ambient temperature.

Envelope design and subassemblies for the tube are shown in Fig. 1. Cylindrical support of the cathode, grid and anode contributes to overall ruggedness. The external anode can accommodate higher dissipation than a conventional interior anode glass envelope thyratron of the same size. Electrical connection to the anode is made by a threaded stud brazed to the anode cup. Grid and cathode have flange-type connections. Power is applied to the cathode and reservoir filaments through pins in the base. The other filament connection is common with the cathode flange.

Ceramic Seals

Ceramic-to-metal seals are made by a titanium hydride process. The ceramic is sprayed with titanium hydride and then a nickel washer is vacuum-brazed to the ceramic using pure silver solder in the butt type of seal. In the pin seals, holes are painted with titanium hydride and then thin-walled kovar tubing is brazed to the ceramic with an alloy of 50-percent silver and 50-percent copper. Detail of pin construction is such that the filament current passes through a nickel wire brazed to the pin base with copper solder.

Figure 2 shows the internal construction of the tube. The molybdenum anode is brazed to the copper anode cup using gold nickel eutectic alloy. The grid cup is made of 0.050-in. copper to provide good thermal conduction away from the grid aperture region. Thickness is decreased to 0.022 in. in the flange area to reduce seal stress.

Cathode Design

A number of closely spaced straight vanes are used in the cathode, Fig. 3, to allow it to have a large emitting area in a small overall volume. Vane height is 0.5 in. The cathode filament lies flat beneath the cathode base plate. Heating efficiency of the cathode is such that only 85 w is required for 100 sq. cm of area. Reservoir used contains 3.8 grams of titanium loaded

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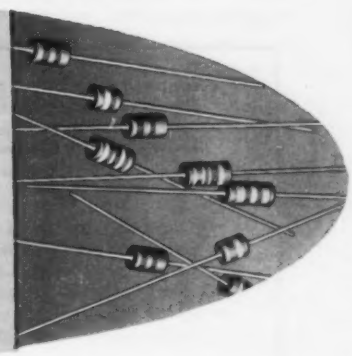

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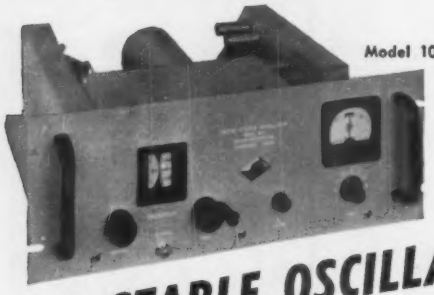

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to a concentration of 16 liter-millimeters of hydrogen for a fill pressure of 375 microns.

A new reservoir using lanthanum in place of titanium is due for incorporation in the tube. An advantage of the new reservoir material is that it exhibits a plateau in the equilibrium pressure-concentration relation in the pressure range at which thyratrons operate and at operating temperatures desirable for pressure stability considerations. A four-fold gain in storage capabilities is realized compared to the titanium reservoir. And only one-eighth the weight of active material must be used.

FIG. 4—Tube mounted in a special socket

Testing

The tube is presently undergoing an Acceptance Testing Program for the Signal Corps. Tubes have been operated previously in excess of 1,000 hours at 25 kv peak anode voltage, 1,000 amp peak cathode current and 1.25 amp average.

The 1802 triggers easily, has less than 0.005 μsec jitter and has a low starting voltage. Envelope temperatures of 400 C are permissible. Operation at prr's in excess of 50,000 pps is possible. The cathode has delivered peak currents of 10,000 amp at pulse widths in the order of one μsec.

Tube design has been tested satisfactorily at a shock of 500 g and at vibration of 10 g up to 2,000 cycles. A socket designe1 for the tube is shown in Fig. 4. The grid flange is clamped with stainless-steel brackets. Threaded inserts in

Mycalex hold the clamping brackets. Stainless-steel connectors used on the filament pins provide a large contact area.

New Synthetic Rubber-Resin Adhesive

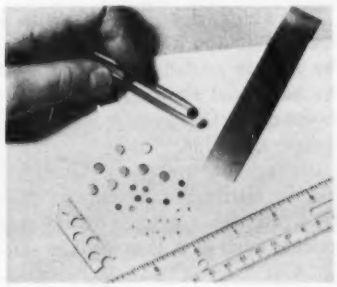
SPECIALLY FORMULATED for laminating Mylar to electrical insulating materials, Bondmaster L379 is a synthetic, rubber-resin adhesive developed by Rubber and Asbestos Corp.

The new adhesive is said to have superior resistance to organic solvents and hot oils. It also features superior resistance to heat-aging, according to the manufacturer.

The adhesive is available in two solids concentrations — 20-percent solids with a viscosity of 400 to 1,000 centipoises and 30-percent solids with a viscosity of 4,000 to 7,000 centipoises.

Rhenium Available Commercially

RHENIUM has received much attention (ELECTRONICS, p 36, Nov. 10, 1957) as an important material for electronic applications. But until a recent announcement by Chase Brass and Copper Co., the material has not been available commercially in this country.



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AMPLIFIER CHARACTERISTICS: Maximum voltage gain of 60-DB; maximum output 10 volts; output impedance is 300 ohms. Frequency response flat within 1 DB from 10 to 250,000 cps.

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Cold Soldering Seals Transistors

MOLECULAR ADHESION will join freshly soldered surfaces in a mechanically strong thermal and electrical bond when the surfaces are placed in contact under pressure. This technique, called cold-soldering, is used to hermetically seal transistor assemblies at the RCA Semiconductor and Materials Division plant, Somerville, N. J.

Cases Prepared

Cases are prepared with a bead of solder around the inside lip. Rosin-core solder preforms are spread on a flat surface. The open end of the cases are pressed over the preform rings so the rings wedge in place. The cases are placed on an asbestos-covered turntable which carries them under a gas flame, melting the solder into a bead on the lip.

The bead is reamed to mate with the transistor stem assembly. A turntable with chucks around the outer circumference is used. Each chuck opening is tapered so that the first impact of the reamer bit seats the case, preventing it from spinning or pulling free when the bit withdraws.

A standard twin-head reamer is used. The table indexes 2 cases at a time. After reaming, a knockout frees the cases from the chuck. As the cases are freed, high pressure air removes chips and blows the cases down a discharge chute. The cases are cleaned by vapor degrease and filled with dielectric fluid.

Cases Sealed

Cases and stem assemblies, which are solder electro-plated before assembly, are hermetically sealed in a controlled atmosphere chamber containing a conventional small air press. Press pressure is 50-60 psi. The bed of the press is stationary.

Using tweezers, the operator places a filled case in a well in the press bed. She then places a stem assembly over the shell, using tweezers, so that the stem leads fit up into a hole in the upper chuck (Fig. 1).

The press is operated with palm switches. Friction holds the case of the sealed transistor in the press bed so that the leads pull free of the upper chuck.

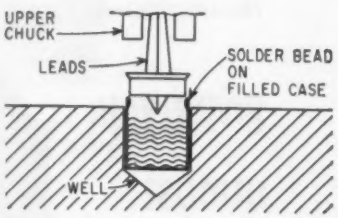
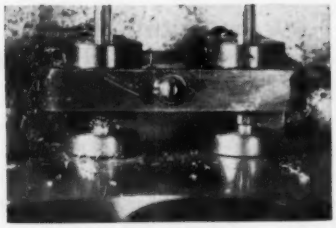
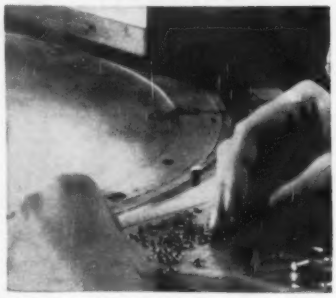


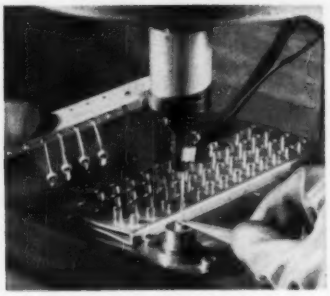
FIG. 1—Tinned surface of transistor stem mates with solder bead



Close-up of case holding chucks and twin reamer

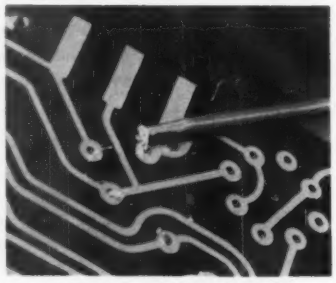


Operator presses case over solder ring, places it on turntable



Cold solder press, loading position in controlled atmosphere case

Twist Fastens Wires to PC Board



Tool pulls twist firmly to board

WIRES CONNECTING an external component to a printed circuit board often must be fixed to the board to prevent the wires from falling out during subsequent transport and assembly.

N. V. Philips Gloeilampenfabrieken, Eindoven, Netherlands, fixes the wires in place with a simple twist. The method also ensures a reliable connection when the board is dip soldered.

The stripped end of the wire is inserted in the hole (Fig. 1a) and the end is curled (Fig. 2b) with the hand tool shown in Fig. 2 and the photos. Component leads were bent by machine.

During the operation, the board is held upright in a fixture. The wires are later connected to components such as a loudspeaker. De-

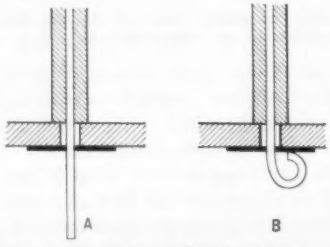
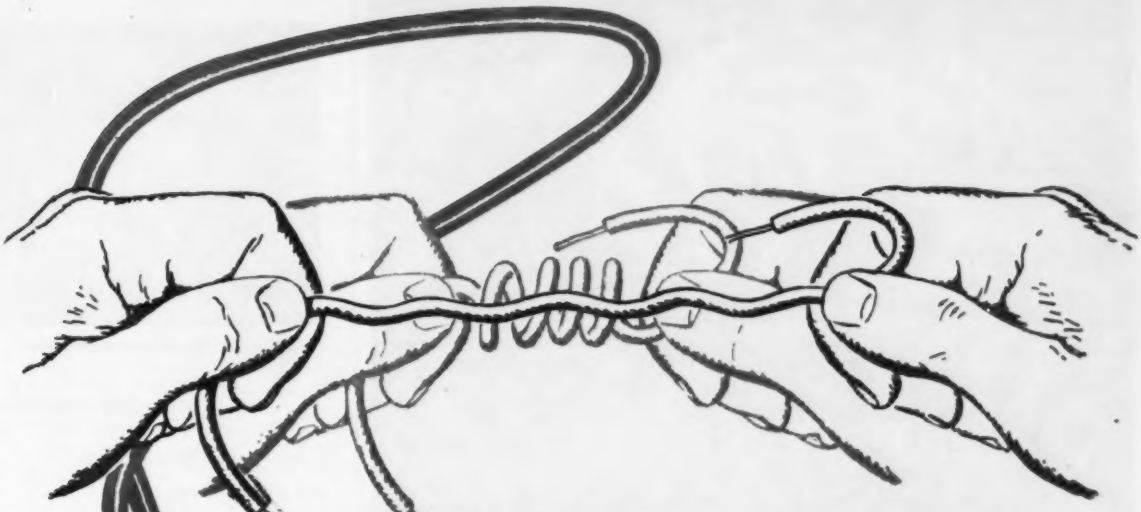


FIG. 1—Wire is inserted and curled



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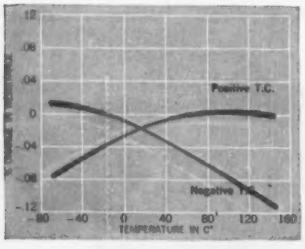

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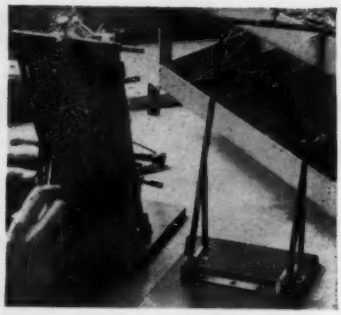


Fixture slopes board toward operator

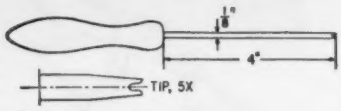


FIG. 2—Wire curling tool

tails of other steps in the assembly of the radio chassis are contained in an article by R. van Beek and W. W. Boelens, Philips Tech. Review, Vol. 20, No. 5.

Adjustable Fixture Grinds Plastic Parts

GRINDING of various precision angles on small plastic parts is handled with a single-position grinder and an adjustable fixture at Unimax Switch Division, W. L. Maxson Corp., Wallingford, Conn.

The setup grinds mounting pads on Bakelite bases of MX type snap-acting switches. The degree to which pads are ground controls overtravel and operating force, characteristics which are varied according to switch model.

The basic framework of the fixture surrounds the grinding wheel and provides a stable platform parallel to the axis of the wheel. The wheel is kept dressed along its axis.

A carriage is pivot-mounted on top of the frame, as shown in Fig. 1. Both frame and carriage are cut away to accommodate the wheel. A plate is mounted on ball bearings in the carriage tracks, so the plate can move back and forth. The switch bases fit in a cutout in the plate.

The plate is pushed back and forth by hand with a handle which is also a spring-mounted lever. A rod in the center of the lever pushes the switch bases down into the cutout, bringing the pads in contact

with the grinding wheel at the correct grinding angle.

The carriages and plate are raised to the desired grinding angle by a set screw which passes through the top deck of the frame. Another set screw, on the bottom deck of the frame, is used for fine adjustments

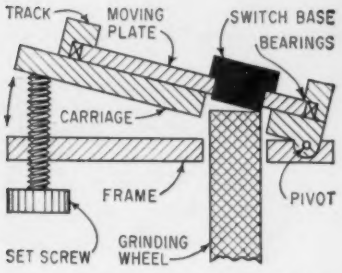
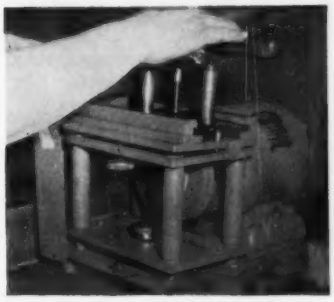


FIG. 1—Diagram of carriage and plate mounting

Grinder in open position. Contact rod is at top center



Grinder in use. Contact rod is depressed by lever

in depth of cut. Both set screws are engraved with scales which indicate depth and angle of cut.

The operator inserts a switch base in the cutout, depresses the lever and moves the plate back and forth between stops in the carriage until there is no more grinding.

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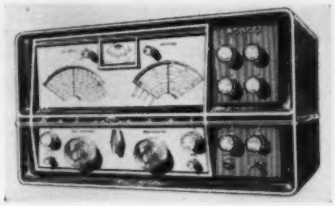
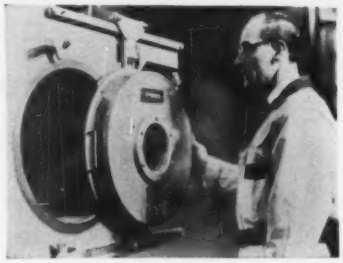
Receiver
for communications

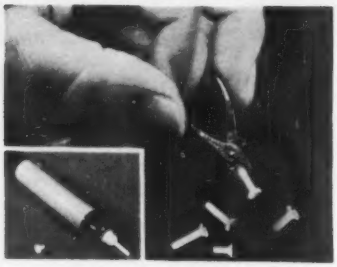


NATIONAL CO., Malden, Mass. Model NC-400 is an 18-tube communications receiver with a frequency range of 540 kc to 31 mc in seven bands. It has an extreme selectivity range of 16 kc to 150 cps with i-f and crystal filter supplied. With accessory filters it has a selectivity range of 16 kc to 500 cps. Sensitivity is approximately 1 μv for a 10 db signal/noise ratio. Unit lists for $895. **Circle 350 on Reader Service Card.**

Vacuum Baking Oven
for outgassing



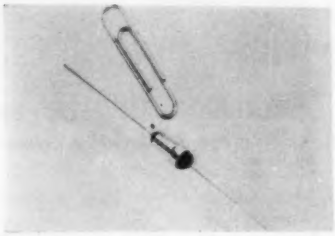
F. J. STOKES CORP., 5500 Tabor Road, Philadelphia 20, Pa. Manufacture of semiconductor components calls for the fabrication and assembly of thin slices of crystallized silicon, germanium, or other highly reactive materials. Outgassing the materials calls for a very high vacuum. Certain other operations—such as fusing it into the subassembly—require moderate amounts of heat, and must be carried out in a nonoxidizing environment. For this purpose the company has developed a special vacuum baking oven. **Circle 351 on Reader Service Card.**



Tiny Machine Screws
molded nylon

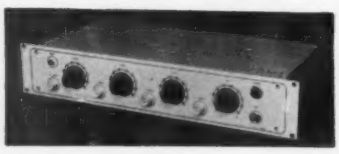
GRIES REPRODUCER CORP., 125 Beechwood Ave., New Rochelle, N. Y., has available miniature molded nylon machine screws with sizes of No. 2 and No. 3. The tiny fasteners may be used in many electronic applications such as the peaking adjustment of Tektronix, Inc.'s low capacitance probes. Precise mechanical dimensions that stand up to continual resetting of the screw, point up nylon's inherent toughness. Nylon parts are stable, do not contribute to drift or other "gremlin phenomena" in electronics use. **Circle 352 on Reader Service Card.**

Capacitor
for p-c boards



TELECOMPUTING CORP., 915 N. Citrus Ave., Los Angeles 38, Calif., announces a new microminiature feed-through capacitor. It is designed for printed circuits, and is thermal-shockproofed to resist damage caused by high temperature solder dipping. Only 0.590 in. long, with a mounting diameter of 0.155 in., the capacitor has a high degree of stability over a full temperature range from −55 C to +150 C. It is available in ratings up to 2,200 $\mu\mu$f at 200 wvdc. **Circle 353 on Reader Service Card.**

Delay Generator
crystal controlled



NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa. Model 1104 crystal controlled delay generator combines transistor circuitry with modular-printed circuit packaging. Any delay from 10 to 10,000 μsec may be selected through the use of front-panel calibrated switches. A 1-mc

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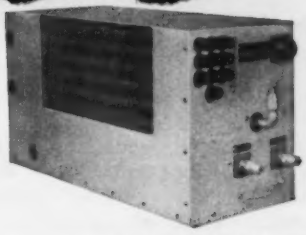
Temperature, Pressure, Moisture, Dust

Expanding aircraft performance creates new problems in protecting electronic equipment under extreme altitude and ambient conditions. Eastern's long experience in the field helps you to recommend electronic gear with confidence that performance will be reliable at temperatures from — 55°C to +55°C; from zero to over 70,000 feet.

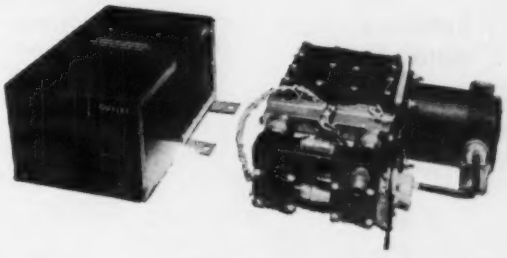
Cooling Units, with or without refrigeration cycles, provide safe operating temperature limits in electronic equipment. Pressurization Units that meet government specifications maintain proper operating pressures at various altitudes, and utilize dehydrators that remove moisture and dust from ambient air. A program of research and development continually expands performance ranges to provide customized units to meet your needs.

When your problem is to make your electronic equipment perform efficiently under tough conditions, meet the challenge by asking Eastern for complete and creative engineering help.

Write for Eastern
AVIONICS BULLETIN 340



REFRIGERATION COOLING UNIT



1500 SERIES PRESSURIZATION UNIT

EASTERN AVIATION PRODUCTS

Eastern INDUSTRIES, INC.

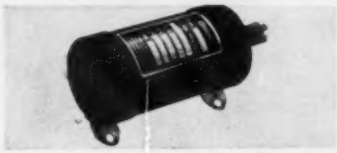
100 Skiff St. Hamden 14, Conn.

West Coast Office: 1608 Centinela Avenue — Inglewood 3, California — Phone ORegon 8-3958

crystal controlled oscillator stabilizes the generator and keeps the jitter time to less than ± 0.5 μsec at the maximum range. Input pulses may be either positive or negative and have the wide range of acceptance of from 5 to 40 volts. **Circle 354 on Reader Service Card.**

Control Assembly
miniaturized

THOMAS A. EDISON INDUSTRIES, McGraw-Edison Co., 61 Alden St., West Orange, N. J. Model 297-115-3 magnetic amplifier control assembly, measuring 1¾ in. in diameter by 3⅝ in. long, is designed for use with the Edison continuous cable aircraft fire detection system. The control weighs only 0.8 lb and does not require shock mounting. It consumes only 1 w for either standby or alarm and will carry a load of 170 ma at 28 v d-c. **Circle 355 on Reader Service Card.**

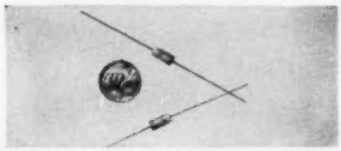


Trimming Pots
humidity protected

DAYSTROM PACIFIC, 9320 Lincoln Blvd., Los Angeles 45, Calif. Series 308 Decatrim subminiature trimming pots feature complete humidity protection, high environmental stability and improved resolution. Of special interest is the air suspension resistance element. No cements or potting compound are allowed to contact resistance wire. Thus possibility of damage from stressing the wire is eliminated, and the low temperature coefficient winding is able to retain its characteristics from one duty cycle to the next. **Circle 356 on Reader Service Card.**

Selenium Rectifier
small size

BRADLEY SEMICONDUCTOR CORP., 275 Walton St., New Haven 11, Conn. Series SP7K miniature low cost selenium rectifier performs efficiently up to 125 C. Case length is ⅜ in. for 10 to 30 v units and ½ in. for 40 to 80 v, with 1½ in. leads. Peak inverse voltage ranges from 37 to 296 at 1 ma, with 0.200 ma reverse leakage at 25 C ambient. A special feature of the rectifier is the nylon seal, to resist humidity, salt spray, and fungus growth. **Circle 357 on Reader Service Card.**

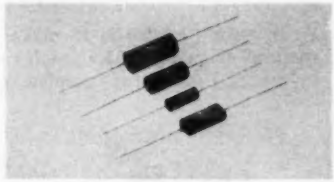


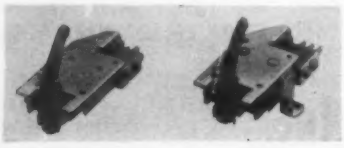
Vibration Pickup
miniature size

MB MFG. CO., P. O. Box 1825, New Haven, Conn. Type 11 vibration pickup, named the Vibramite, is an eddy current damped unit with a flat response curve over its full operating range. While miniaturization has permitted substantial size and weight reduction, all of the desirable characteristics of MB velocity pickups have been retained. These characteristics include self-generation with no cathode follower or other impedance matching amplifier required; and good temperature stability with high electrical output. Acceleration up to 50 g for continuous duty and up to 100 g intermittently do not damage the unit. **Circle 358 on Reader Service Card.**

Resistors
metal film

OHMITE MFG. CO., 3601 Howard St., Skokie, Ill., has expanded its series 77 metal film resistor line. New sizes include ¼, ½ and 1 w units, the latter in both full cylindrical and semi-cylindrical shape. Series 77 metal film resistors consist of a special film of metal alloy permanently bonded to glass. This is sealed in a plastic case. **Circle 359 on Reader Service Card.**





Hook Switch
two series

SWITCHCRAFT, INC., 5555 N. Elston Ave., Chicago 30, Ill., announces a hook switch for use where it is desirable to actuate the switch by hanging an accessory on a hook, such as hanging up a head set or microphone. It is available in two series for two different types of mounting. Series 14000 mounts by

CIRCLE 177 READERS SERVICE CARD →

A HOFFMAN SEMICONDUCTOR APPLICATION CASE HISTORY

Over 8,760 hours ago, the successful
Vanguard Satellite was launched.
We salute the U.S. Navy
and its cooperating agencies, as the Satellite,
launched a year ago, continues in orbit.

THIS POWER RELIABILITY PROBLEM HAD TO BE SOLVED

For new semiconductor application ideas,
visit Booths 3242-3243 at the I.R.E. Show.

FOR SPACE VEHICLES

Hoffman Silicon Solar Cells were the solution

The transmitter of the U.S. Navy's Vanguard Satellite required an extremely reliable power source with the highest possible light energy conversion efficiency. Hoffman Silicon Solar Cells were chosen to do this exacting job. To date a new record has been set for continuous electrical power in outer space (with no "time-out" for refueling).

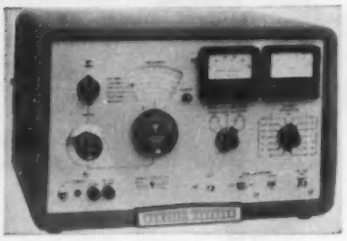
If you require a highly dependable electrical power supply, with a wide operating and storage temperature range of from −65°C to +175°C, a higher light conversion efficiency (up to 10%), an extended spectral response range of from 4,000-11,500 angstroms, benefit from Hoffman's unequaled experience as the pioneer in the commercial development of Silicon Solar Cells and their uses.

For details consult the Hoffman Solar Cell applications specialist in your immediate area or write to Department SS.

If you need a job in electronics done quicker and better, contact

Hoffman Electronics (H)
CORPORATION
SEMICONDUCTOR DIVISION
930 PITNER AVENUE EVANSTON, ILLINOIS

frame (4 threaded holes). Series B14000 has bracket for mounting on panel behind switch (2 threaded holes), space only permits up to total of 4 "C" circuits. The hook switch requires a minimum of depth behind the panel. Relatively long springs without any "forms" at point of flexing insure suitable spring action for long life. **Circle 360 on Reader Service Card.**



Wave Analyzer
20 cps to 50 kc

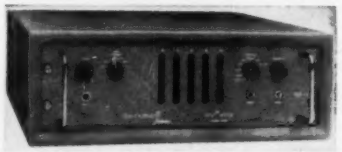
HEWLETT-PACKARD CO., 275 Page Mill Road, Palo Alto, Calif. Model 302A wave analyzer operates from 20 cps to 50 kc. It separates an input signal into its individual components so that the fundamental, harmonics and intermodulation products may be separately measured and evaluated. Completely transistorized, it provides increased versatility, low power consumption, elimination of warm-up time, and portable operation from an external d-c source. **Circle 361 on Reader Service Card.**

Diode Housings
metallized ceramic

MITRONICS, INC., 1290 Central Ave., Hillside, N. J., is producing a new line of diode housings made of metallized ceramic (steatite and high alumina). They feature better heat dissipation, better thermal and mechanical shock characteristics, lower assembly temperatures, and elimination of expensive sealing equipment. **Circle 362 on Reader Service Card.**

Frequency Counter
solid-state

BECKMAN INSTRUMENTS, INC., 2200 Wright Ave., Richmond 3, Calif., has available a new EPUT meter, fully transistorized to meet stringent reliability requirements. Instrument measures frequencies from 10 cps to 200 kc with accuracy up to 1 part in 10^8. Occupying only 5¼ in. of rack space and weighing under 25 lb, the unit operates dependably at any ambient temperature from −4 F to 150 F. A 1-2-4-8 binary coded output is available to drive data converters. **Circle 363 on Reader Service Card.**

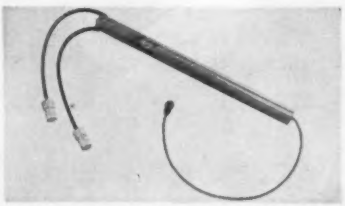


Tv Camera
high reliability

BLONDER-TONGUE LABORATORIES, INC., 9 Alling St., Newark 2, N. J. The TVC-1B tv camera, an improved version of the TVC-1A Observer, includes an interlace bypass system, increased stability in the counter circuits, more effective 600 line resolution in the scanning system, more precise optical focusing of the camera tube, new positive-lock settings on frequency divider potentiometers, and restyling of the sync generator for operating convenience. **Circle 364 on Reader Service Card.**

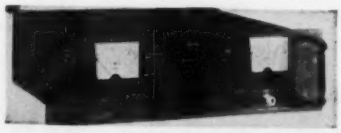
TWT Amplifier
500 to 1,000 mc

HUGGINS LABORATORIES, 999 East Arques, Sunnyvale, Calif. Type HA-45 low noise uhf-band twt amplifier features small signal gain of 25 db (min.); noise figure, 10 db (max.); magnetic field, 850 gauss; capsule length, 16¼ in.; capsule diameter, 1⅜ in. Tube is suitable as the first stage of a receiver in many microwave applications. Noise figure reduction is accomplished by multianode techniques. **Circle 365 on Reader Service Card.**



Power Supply
accurate regulation

MID-EASTERN ELECTRONICS, INC., 32 Commerce St., Springfield, N. J. Model 100 transistor power supply features stable output voltages from 0 to 36 v d-c at 5 amperes continuous duty. Line and load regulation is better than 0.1 per-



IF DRIFTING* DOESN'T BOTHER YOU...

VITREOUS ENAMEL POWER RESISTORS MAY DO

But only **IRC**'s RESISTEG Coating can assure stability under load life

Exclusive RESISTEG Coating accounts directly for the superior stability of IRC Power Wire Wound Resistors. IRC RESISTEG Coating sets at 205°F.; whereas vitreous enamel must be cured at 1200°F. or higher! IRC's low-temperature curing doesn't change the position of the wire, and turns do not shift together.

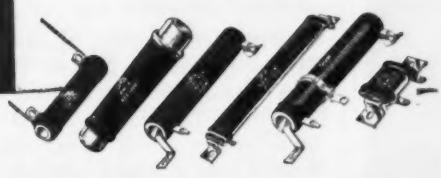
Also, low-temperature cured RESISTEG Coating doesn't require the wire stretching, with its "workhardened" aftereffect, that is needed to prevent wire shifts during high-temperature curing.

RESULT: For the same temperature rise, the resistance change of RESISTEG Coated units is approximately half that of vitreous enameled resistors. IRC power resistors need no derating . . . even at high values. For greater stability, always specify IRC Power Wire Wound Resistors . . . with exclusive low-temperature cured RESISTEG Coating.

*IRC RESISTEG Coated Resistors have less drift and resistance change under load life; vitreous enameled resistors are not equal in stability.

WRITE FOR CATALOG COVERING MORE THAN 50 IRC POWER RESISTORS INCLUDING MIL TYPES

Visit IRC at the IRE—Booth 2821



Wherever the Circuit Says— IRC

INTERNATIONAL RESISTANCE COMPANY, Dept. 375, 401 N. Broad Street, Philadelphia 8, Pa.

...AND ANOTHER
Silicon Rectifier
FROM
FANSTEEL

NEW

20 AMP.
Silicon Power Rectifier

The 6A—just added to Fansteel's expanding line of dependable silicon rectifiers—carries a full 20 amp. load in half-wave circuits; up to 60 amps in bridge circuits. It has rated peak reverse voltages from 50 to 400 V. in 50-volt multiples.

The new 6A Rectifier operates at ambient temperatures up to 165°C. and is unaffected by storage temperatures from −65°C. to 200°C.

This dependable, highly stable unit is especially suited to high temperature operation in all types of power circuits. It will give long, trouble-free performance consistent with other Fansteel electronic components. The 6A unit is hermetically sealed and is of extremely rugged construction. It is the most compact unit of its rating and can be mounted in any position.

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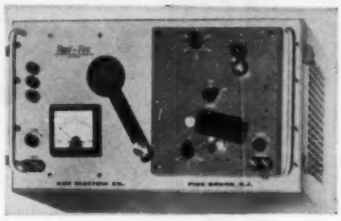
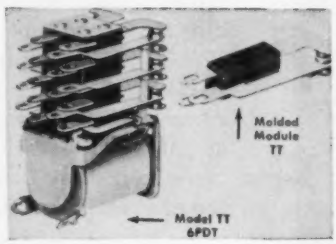
cent and output can be limited to any value from 0 to 5 amperes through a front panel selector. Overshoot is not measurable thus insuring instantaneous protection to rated components and external circuitry. Recovery is better than 50 μsec and ripple and noise less than 1 mv at full load. **Circle 366 on Reader Service Card.**



Speed Compressor and expander

KAY ELECTRIC CO., Maple Ave., Pine Brook, N. J. The Vari-Vox is a versatile, flexible speech-time compressor and expander. It operates by repeating or discarding minute parts of audio signals and retransmitting the complex signal so that complete intelligibility is retained. The Vari-Vox can transmit information fed into it at 18 different speeds ranging from twice the original rate down to one-half the original rate. Degree of compression or expansion vs speed of input recording determines intelligibility. **Circle 367 on Reader Service Card.**



Relays molded module

OHMITE MFG. CO., 3601 Howard St., Skokie, Ill. Model TT and TS relays feature molded module construction. The module is a standard, spdt spring combination molded into a single compact assembly. With the springs held in

a matrix of tough, extra-high-temperature plastic, operating stability and permanence of spring adjustments are considerably improved. Models TT and TS are designed to meet MIL-R-5757C and MIL-R-6106C respectively. **Circle 368 on Reader Service Card.**

Digital Voltmeter transistorized

NON-LINEAR SYSTEMS, INC., Del Mar, Calif. Model V-34 is a completely transistorized stepping switch digital voltmeter which automatically measures voltages over the range of $\pm 100\ \mu v$ to $\pm 1{,}000$ v. Increased reliability is assured by a new digital logic which results in the fewest stepping switch operations possible during the balancing process. Readings are thereby made in the shortest possible time, and stepping switch life is extended since only $\frac{1}{3}$ as many steps are needed per reading. The new logic also eliminates the need for a sensitivity control when measuring noisy or varying signals. **Circle 369 on Reader Service Card.**

Standard Solar Cells check efficiency

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., has available secondary standard silicon solar cells. They are specifically designed for calibration of artificial light sources in terms of solar energy radiation. They may be considered to be the solar cell analog to the pyroheli-

MORE BIG NEWS FROM FANSTEEL

NOW...125°C. OPERATING TEMPERATURES

In units rated from 6 to 35 volts, —55°C. to 85°C. operation for units rated at 50 and 60 volts.

Plus

TWICE THE CAPACITY

Capacity has been increased as much as 100% without increasing case size. Four convenient case sizes cover the broadest and most complete list of ratings available.

THE NEW FANSTEEL S-T-A Solid Tantalum Capacitor

It's another step by Fansteel to provide a *complete* range of Solid Tantalum Capacitors designed to meet the ever-increasing needs for greater capacity in subminiature sizes.

It's available in capacity ranges of .0047 to 330 mfd ... from 6 to 60 volts (wvdc).

Assures unfailing reliability where extremely small size, higher capacitance and extended operating temperatures are required.

S-T-A CASE SIZE

Series	Length	Dia.
5	.250	.125
6	.438	.175
7	.650	.279
8	.750	.341

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BIG THINGS
are always happening
AT
FANSTEEL

IN SILICON RECTIFIERS

NEW
IN1600 Series
750 MILLIAMPERES
Carries 2½ times more amperage at no increase in size. Complete reliability and dependability in applications requiring operating temperatures to 165°C., ratings from 50 to 600 volts. Write for Bulletin 6.302.

NEW
20 AMP.
The 6A carries a full 20-amp. load in half-wave circuits . . . up to 60 amps. in bridge circuits. It's built to withstand operating temperatures up to 165°C. with maximum reliability and dependability. Write for latest information.

NEW
35 AMP.
The 4A carries a full 35-amp. load in half-wave circuits . . . up to 100 amps. in bridge circuits. It's built to withstand operating temperatures up to 165°C. with maximum reliability and dependability. Both 20 and 35 amp Rectifiers available with flexible lead. Write for latest information.

IN SELENIUM RECTIFIERS

OVER 400,000 DIFFERENT STACK COMBINATIONS AVAILABLE
Available in all standard cell sizes and circuit arrangements to meet any specific requirement—from a few milliamperes to power loads of many kilowatts. Write for Bulletin 6.400.

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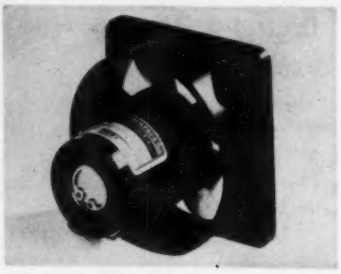
FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U.S.A.

ometer standard. Manufacturers using them will be able to evaluate incoming solar cells for efficiency, without the need of a pyroheliometer or other complex light-measuring device. **Circle 370 on Reader Service Card.**



Axial Blower
miniature unit

AIR-MARINE MOTORS, INC., 369 Bayview Ave., Amityville, N. Y., announces a new miniature tube-axial fan ideally suited for spot cooling electronic equipment in restricted spaces. Model S2223-3, using a 1 in. diameter motor, at 16,500 rpm delivers 40 cfm at 0 in. s-p. It operates from a 200 v, 3 phase, 400 cycle source. It can withstand ambient temperatures of up to 125 C with a minimum life of 2,000 hr. **Circle 371 on Reader Service Card.**

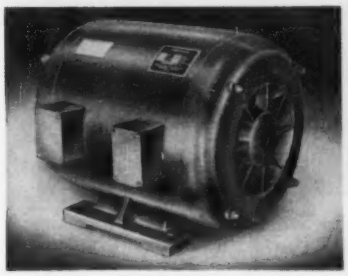
Silicone Rubber
quick-setting

DOW CORNING CORP., Midland, Mich. Silastic RTV 502 is a fluid, quick-setting, room temperature vulcanizing silicone rubber. With the addition of a catalyst, the fluid material sets up to become a rubber in about 30 minutes at room temperature. It remains rubbery from — 70 to 500 F, and has good

electrical insulating properties. It is useful for potting and encapsulating electronic parts, and as a shock and vibration absorber for delicate components. **Circle 372 on Reader Service Card.**

Pressure Standard
precision unit

BORG-WARNER CORP., 3300 Newport Blvd., Santa Ana, Calif., has developed a precision electronic pressure standard, the D-311 Vibromanometer. This is a simplified direct-f/m-conversion design intended to replace existing mercury manometers and also for use as a versatile process, measurement, and check-out standard. **Circle 373 on Reader Service Card.**



Frequency Converter
low audible noise

GEORATOR CORP., Manassas, Va., announces an improved frequency converter that delivers 400 cps from a 60 cps source. Combined with immunity to short-circuit, it features small size and weight, high conversion efficiency, low audible noise, stable output voltage despite fluctuating input, good wave form and total absence of r-f noise. **Circle 374 on Reader Service Card.**

Connector
rack and panel

AMP INC., Harrisburg, Pa. Designed for use in an airborne com-

BIG THINGS
are always happening
AT
FANSTEEL

NEW S-T-A SOLID TANTALUM CAPACITOR

Unsurpassed stability at operating temperatures from −55°C. to 125°C., with double the capacity rating in the same case size. Available in ranges of .0047 to 330 mfd., 6 to 60 volts (wvdc). Write for Bulletin 6.112.

NEW "PP" TYPE TANTALUM CAPACITOR

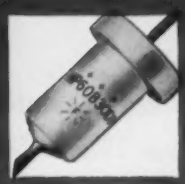
Features new shock and vibration resistant construction (specially designed anode base support) *at no increase in price.* Outstanding frequency stability and extremely low electrical leakage. Occupies minimum space yet provides extremely high capacity ratings. Write for Bulletin 6.100.

NEW BLU-CAP TANTALUM CAPACITOR

Provides maximum economy where wide capacity tolerances are permissible. The capacity tolerance for the BLU-CAP Capacitor is −15%, +75%. Write for Bulletin 6.120.

"HP" TYPE TANTALUM CAPACITOR

Gives exceptional performance in applications requiring high ambient temperature resistance (to 125°C.) and vibration resistance. Write for Bulletin 6.111.



FANSTEEL RELIABILITY

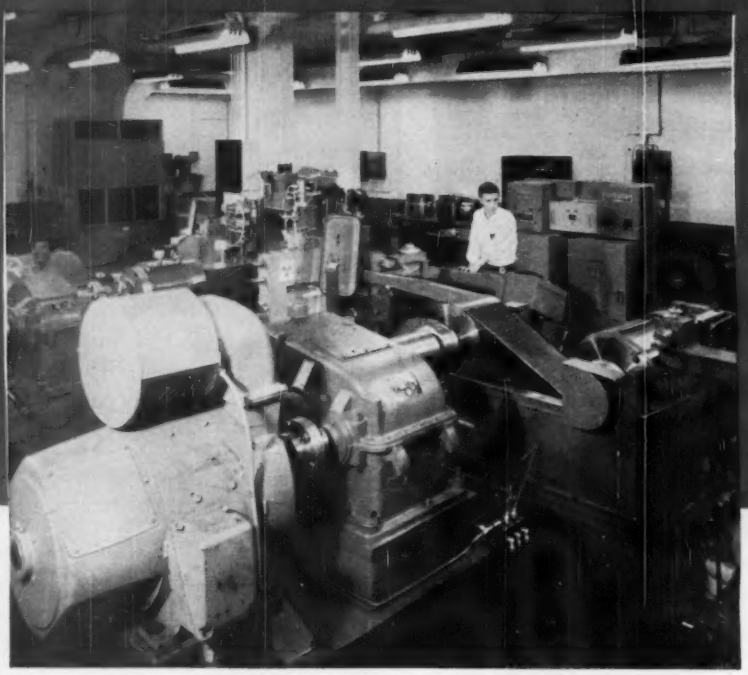
Visit Us At Booths 4021-4022
I.R.E. SHOW

C593A

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U.S.A.

TANTALUM...

Nature Created it; Fansteel Made it Work



The world's largest Sendzimir Mill used in tantalum production. This mill, in the Fansteel North Chicago plant, regularly produces 0.0003 inch thick Capacitor Grade Tantalum Foil in continuous strip.

TANTALUM, one of the most difficult of all metals to produce, stayed tightly locked in its ore for 101 years following its discovery as an element. Almost no acid would attack the material, yet almost any gas would readily combine with it at temperatures above a dull red heat. In fact, it was named Tantalum because it tantalized the nineteenth century chemists who tried to refine it.

But, in 1922, Fansteel unlocked the door to extensive commercial use of this unusual metal. It was then that Dr. Clarence W. Balke, Fansteel's Director of Research, perfected the first practical method for commercially producing tantalum. Dr. Balke succeeded where many other scientists had failed. He combined the techniques of chemistry, electrochemistry and powder metallurgy to separate tantalum from its ore compounds.

Now, the properties which caused tantalum to be so difficult to make, have become the very properties so useful to the electronics industry. They were especially significant in Fansteel's development of the tantalum capacitor. Fansteel Tantalum answered the need for a material to provide high reliability, low leakage, long life and stability in capacitors.

Out of the research at Fansteel came a grade of tantalum especially suited for use in tantalum capacitors. This grade has been undergoing independent development for several years, and is still being improved. Today, Fansteel Capacitor Grade Tantalum is used by all leading manufacturers of tantalum capacitors to assure complete reliability in their products. This exceptional metal embodies a quality that only the experience of Fansteel research can produce. Fansteel Metallurgical Corporation, Rectifier-Capacitor Division, North Chicago, Illinois.

Visit Us At Booths 4021-4022 I.R.E. SHOW

FANSTEEL®

CAPACITOR GRADE
TANTALUM

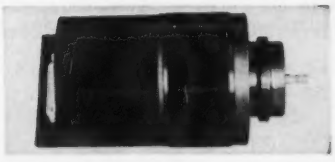
A Premium Grade of Tantalum available to capacitor manufacturers in these forms:

FOIL • SHEET • STRIP • WIRE • ROD • FABRICATED WIRE LEADS
SINTERED POROUS ANODES • METAL POWDER

nector was designed as a lightweight environmental sealed connector for use in an airborne computer. The plug half is mechanically mounted and solder dipped to the end of a printed board while the receptacle half is mounted in a guide rack which permits easy insertion of printed board and plug. **Circle 375 on Reader Service Card.**

Ultrasonic Cleaner
mobile type

THE NARDA ULTRASONICS CORP., Westbury, L. I., N. Y., announces the Redstone, a roll-around automatic industrial ultrasonic washing machine. It can be used with either solvents or tap water. Unit incorporates a power drain, and has a recirculating filter and heating system for the cleaning solution, so that it can be operated under the controlled temperature conditions required by various solvents. **Circle 376 on Reader Service Card.**



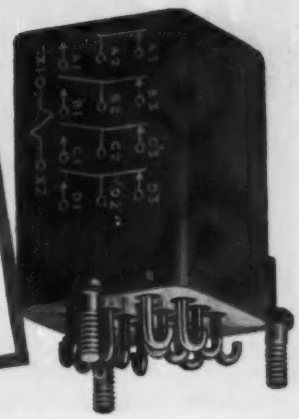
Digital Encoder
shaft position

WAYNE-GEORGE CORP., 1117 Commonwealth Ave., Boston 15, Mass. Type RD-13B Digisyn is a 13 digit, photoelectric, shaft position encoder to replace types RD-13

ALLIED'S 30G RELAY
Miniature 10 Amp 4PDT

Now with Stabilized Construction*

*Includes materials and processing necessary to minimize contact resistance variations and dielectric deterioration during life due to contact contamination, mechanical wear and shift of adjustments with temperature.



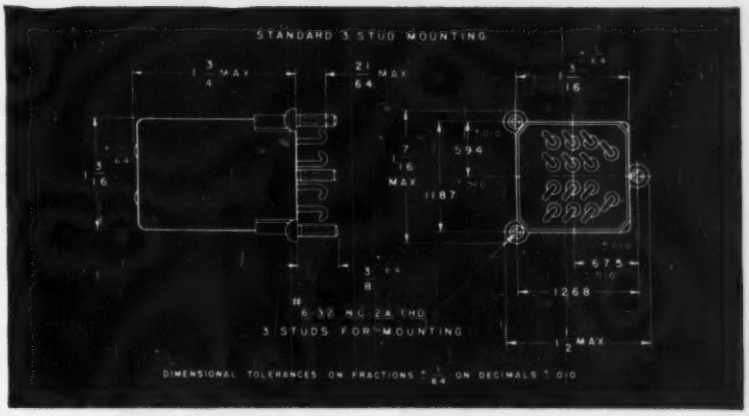
TYPE CH-12D • ACTUAL SIZE

Designed for Resistance to:

Shock—100 gravity units • **Vibration**—5 to 55 cps at 0.5 inch double amplitude, 55 to 2000 cps at 30 gravity units • **Temperature**—from −65°C to +125°C

Other Specifications:

Contact Rating: 10 amperes resistive, 8 amperes inductive, at 29 volts d-c or 115 volts a-c 400 cps • **Weight:** 5.3 ounces • **Dielectric:** 1500 volts rms at sea level, 350 volts rms at 80,000 ft. • **Contact Resistance:** .01 ohm max. initial • **Contact Arrangement:** Four Pole Double Throw



The Allied CH-12D Relay was developed to meet the more rigid requirements of vibration, shock, temperature, rupture and overload conditions of the latest MIL spec. This relay is available with other mounting arrangements for special applications, such as 4 mounting studs or brackets for Allied MHY-12D type 2 stud or 2 hole mounting. For additional information write for Bulletin CH.

ALLIED CONTROL

ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N. Y.

AL189

NEW

High-speed Control for Inductrol* Voltage Regulators

At Booth 2924 . . .

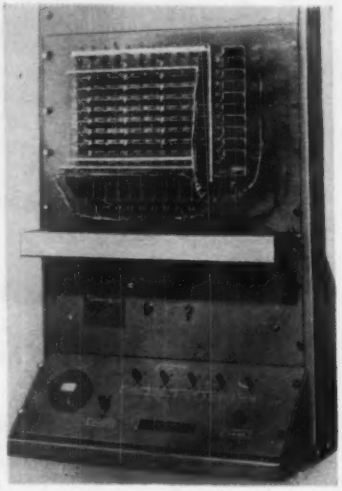
See General Electric's new, high-speed Kettler Control for Inductrol* Voltage Regulators. Designed for precise, flexible voltage control for electronic, military and commercial applications, the unit meets MIL Specification E-164-00B. The new control responds to voltage changes in two cycles or less and has operational accuracy of ±1%, from −60°C to +60°C. See the new control and the complete G-E Inductrol line at Booth 2924. General Electric Company, Schenectady 5, N. Y. 425-24

*Registered trademark of General Electric Co. for induction voltage regulators.

GENERAL ELECTRIC

CIRCLE 185 READERS SERVICE CARD

and RD-13A models. Structural changes increase ruggedness and resistance to vibration and shock. Unit provides outputs of 10 v ± 10 percent over a temperature range of − 40 F to + 165 F and provides a signal to null or one to zero ratio in excess of 100 to 1 over this range. **Circle 377 on Reader Service Card.**



Crossbar Scanner
self-stepping

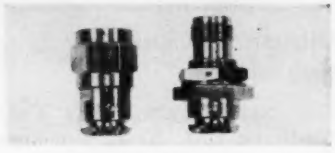
JAMES CUNNINGHAM, SON & CO., INC., P.O. Box 516, Rochester 2, N. Y., has developed a new self-stepping crossbar scanner with optional remote dial control. Model SC-4 scanner is basically a type F crossbar switch with simplified drive circuitry which enables it to connect sequentially a 6-wire circuit with each of 100 sets of 6-wire terminals, at speeds of up to 50 sets per sec. **Circle 378 on Reader Service Card.**

Industrial Laminate
for computer uses

GENERAL ELECTRIC CO., Schenectady 5, N. Y., announces a new transparent Textolite industrial laminate with ideal characteristics for computer circuits and military electronic applications. Designated number 11559, the self-extinguishing epoxy glass laminate has 20,000,000 megohms insulation resistance at 50 C and 500,000 megohms resistance at 165 C. It retains 65 percent of room temperature flexural strength at 150 C. Classified NEMA grade G-11, the new laminate has very high tensile and impact resistance. **Circle 379 on Reader Service Card.**

Indicator Tubes
ultra long life

BURROUGHS CORP., P.O. Box 1226, Plainfield, N. J., announces two additional Nixie indicator tube types with a minimum of 10,000 hours dynamic life. The new tube line of readout devices may be interchanged with the standard tube line where extra long life is required with only minor circuit modifications. Miniature type B-4032 is described as the smallest all-electronic readout of any type and is visible at distances up to 20 ft. The Super size type B-6033 is readable up to 75 ft. **Circle 380 on Reader Service Card.**



Coax Connectors
5,000-11,000 mc

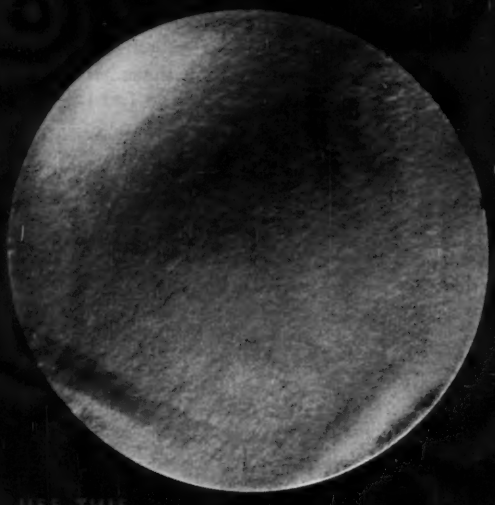
KINGS ELECTRONICS CO., INC., 40 Marbledale Rd., Tuckahoe, N. Y. Two new wide band coaxial connectors in the 5,000-11,000 mc range with absolute reliability of vswr of 1.25:1 or better are announced. Designed specially for missile and precision equipment, each connector can be individually calibrated at every 100 mc point over the entire range if requested. **Circle 381 on Reader Service Card.**

Silicon Transistors
pnp type

FAIRCHILD CONTROLS CORP., 6111 E. Washington Blvd., Los Angeles,

USE *Coors* CERAMICS

WHERE YOU WANT RELIABILITY



USE THIS

This is an unretouched photo of a broken 3" thick section of Coors high alumina ceramic, formed by the *Isostatic Process*. It fractured smoothly and shows a completely homogeneous structure. There are obviously no voids or hidden stresses to cause failure.

NOT THIS

This is an unretouched photo of a broken 3" thick section of high alumina ceramic, formed by the conventional wet process. It clearly shows typical voids and hidden stress patterns inherent in all conventionally made, wet process ceramic parts.

COORS TECHNIQUE PRODUCES UNIFORM PARTS WITH NO HIDDEN VOIDS OR INTERNAL STRESSES

Design uncertainties of ceramic strength and unformity are completely eliminated by the use of Coors Alumina Ceramics formed by the *Isostatic Process**. There are no variations in properties between one ceramic part and another. This is the only ceramic forming technique that can guarantee uniformity between ceramic parts.

Outside of the spark plug field, Coors has pioneered in isostatically forming high alumina ceramics. In this forming technique, blanks are initially produced by pressing dry, unfired powder in a rubber mold under high hydraulic pressure. An accurate inside contour can be formed by pressing the powder around a metal arbor. The uniform pressure from all directions provides uniform compactness and complete homogeneity. The final outside shape is formed by machining the blanks.

In a wet process, the ceramic parts, once formed, must be dried. This drying action causes hidden stresses to develop. And finally, the volume occupied by the water is replaced by air, forming hidden voids and weak spots.

Since the powdered ceramic material used in the *Isostatic Process* is dry before it is formed, the machined blanks go directly into the high temperature kilns. Unpredictable drying necessary in wet processes is thus eliminated.

With Coors Alumina Ceramic parts made by the *Isostatic Process*, the engineer can accurately design for mechanical and electrical properties—an impossibility with any ordinary methods of forming ceramic. For complete mechanical and electrical properties, send the coupon below. Parts to test your design will be furnished at nominal cost.

See Coors Ceramics at the IRE Show. Booth No. 4005

COORS PORCELAIN COMPANY

Manufacturers of High Strength Alumina Ceramics

GOLDEN, COLORADO

COORS PORCELAIN CO., 600 9th St., Golden, Colo.

Please send me detailed Bulletin 1055-A on Coors High Strength Alumina Ceramics and Coors manufacturing facilities.

Name.....Title.....

Company.....

Address.....

City.....State.....

We got our start in Santa Clara County* California

...and we're glad to be here!*

Mr. J. E. Jennings, President of Jennings Radio, explains the desirability of their Santa Clara County location this way:

"In our case, it was primarily the availability of good land for low cost single story construction that made this area so desirable. Of course, we are pleased with our location in Santa Clara County for other reasons, too. These include the variety of excellent service industries nearby and the highly skilled technical help which is so necessary in the manufacture of vacuum electronic components."

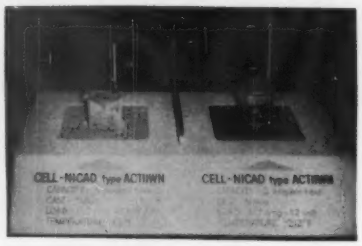
Statements from men like this are very significant. Talk with the people at Jennings. Then forecast your future in this liveable community at the southern tip of San Francisco Bay.

WRITE FOR FREE REFERENCE DATA
Take a minute now to send for the informative booklet, "What Does Santa Clara County, California offer the ELECTRONICS INDUSTRY?"

Greater San Jose Chamber of Commerce
Dept. 2, San Jose, California

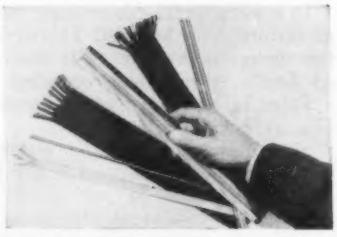
SAN JOSE
Santa Clara County
California

Calif. The 2N1131 and 2N1132 are *pnp* silicon transistors closely matching the 2N696 and 2N697 types. Existence of these closely related devices of opposite polarity affords opportunities for circuit designs based on complementary symmetry. *Pnp* silicon transistors also have special applications by themselves. Typical rise time is 80 millimicroseconds. Dissipation ratings are 2 w at 25 C and 1 w at 100 C. **Circle 382 on Reader Service Card.**



Batteries
nickel cadmium

GOULD-NATIONAL BATTERIES, INC., Easthampton, Mass. Exposed continuously for 10 hours to cold (−65 F) and heat (+212 F) far more intense than batteries usually can withstand, these NICAD nickel cadmium batteries deliver full capacity, operating a 0.5 ampere lamp. They are specified for air and space craft, communications equipment, alarm and signal systems, microwave and telemetering devices. Momentary discharge as high as 25 times rated capacity is possible with NICAD batteries because of their low internal resistance. **Circle 383 on Reader Service Card.**

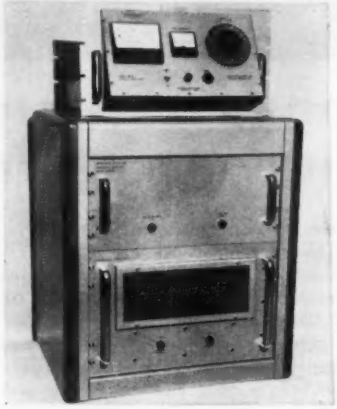


Turbo Ribbon Cable
expanded line

WM. BRAND & CO., INC., Willimantic, Conn., announces an expanded line of Turbo ribbon cable. Line includes larger sizes and 14 colors and striped combinations. Used extensively for airframe and guided missile work, Turbo ribbon cable is finding new applications in transistorized computers and data processing equipment. The flat multiconductor cable may be assembled from single conductors; twisted and jacketed pairs; triples; coaxial cables; shielded and jacketed wires; or any combination of these. **Circle 384 on Reader Service Card.**

Selenium Diodes
subminiature

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa., is introducing the Minifiers, a new line of subminiature selenium diodes. They are designed for use in such specific applications as afc, agc, bias supplies, clamping, clipping, detectors, gating, logic circuity, phase comparators, and sensitive d-c relays. **Circle 385 on Reader Service Card.**



Signal Source
remote tuned

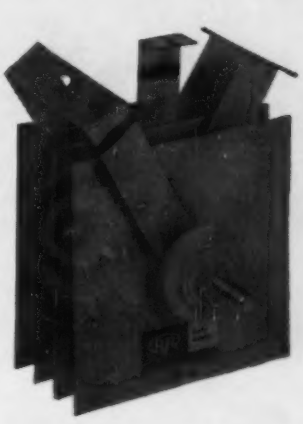
SCIENTIFIC-ATLANTA, INC., 2162 Piedmont Road, N.E., Atlanta 9, Ga. The remote tuning feature of the model 301 makes the signal source especially suited for antenna test applications where the source must be located at great distances from the receiving site. The weatherproof Carcinotron r-f

(Continued on p 179)

FROM GENERAL INSTRUMENT CORPORATION

life expectancy over 100,000 hours

3 times normal current density



no elaborate protective devices required

RADIO RECEPTOR

Tri-AMP

SELENIUM RECTIFIERS

3* AMP/IN²

THE DIFFERENCE AT A GLANCE!

New Tri-AMP 3-phase Bridge		Standard Type 3-phase Bridge	
Dimensions	Amp.	Dimensions	Amp.
4" x 4" *Fan Cooled	54	4" x 4" Fan Cooled	16.8
4" x 4" Convection Cooled	18	4" x 4" Convection Cooled	6.7

Conventional selenium rectifiers are obsolete now that General Instrument has developed the amazing new Radio Receptor TRI-AMP – a completely new selenium semiconductor operating at triple the current density of standard stacks. Even more important, these stacks give complete reliability over a life span of more than 100,000 hours.

TRI-AMP rectifiers have all the advantages of selenium, and elaborate protective devices required by other semiconductors for overvoltage and overcurrent aren't necessary.

Produced with unique equipment, these RRco. rectifiers are available in volume quantities for immediate delivery. For full information, write today to Section E-3R

RADIO RECEPTOR COMPANY, INC.

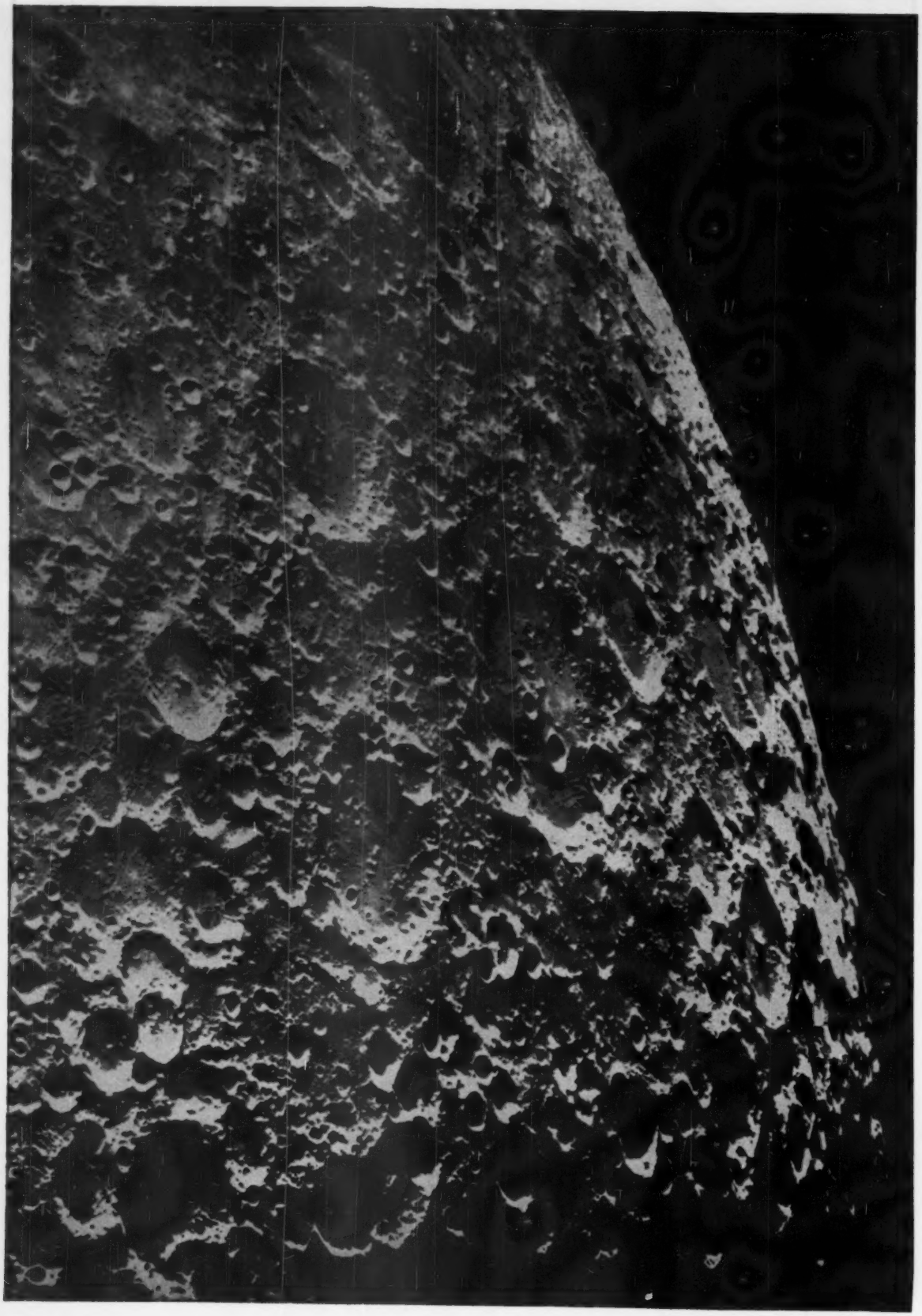
Subsidiary of General Instrument Corporation

240 Wythe Ave., Brooklyn 11, N. Y., Telephone: Evergreen 8-6000

GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION, AUTOMATIC MANUFACTURING DIVISION, RADIO RECEPTOR COMPANY, INC. AND MICAMOLD ELECTRONICS MANUFACTURING CORPORATION (SUBSIDIARIES)

GENERAL INSTRUMENT DISTRIBUTORS: Baltimore: D & H Distributing Co. • Chicago: Merquip Co. • Cleveland: Pioneer Electronic Supply • Harrisburg, Pa.: D & H Distributing Co. • Los Angeles: Valley Electronics Supply Co., Burbank • Milwaukee: Radio Parts Co., Inc. • Newton, Mass.: Greene-Shaw Inc. New York City: Hudson Radio & Television Corp., Sun Radio & Electronic Co. • Philadelphia: Herbach & Rademan, Inc. • San Diego: Shanks & Wright, Inc. San Francisco: Pacific Wholesale Co. • Seattle: Seattle Radio Supply • Tulsa: Oil Capitol Electronics.

See us in March at the IRE Show in New York—Booths 2211 to 2217

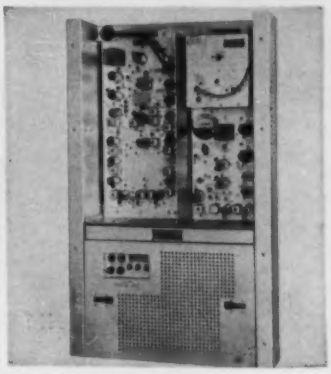


"THE MILITARY REQUIREMENTS FOR MOON BASE"
This is the title of one of four major proposals developed within the past 12 months by Martin for the military and astroscientific branches of our Government. The importance of this proposal is two-fold: the inevitability of an actual moon base program by this country within the next 5 years, and; we could and can undertake such a project now — not in theory but in "hard" engineering design. In preparation for that inevitability, Martin already has built the capability for it. One important step was the creation of the Space Flight Division*, which is now directing Phase 1 of Project DYNA-SOAR.

*The Space Flight Division is one of the 7 divisions of Martin

MARTIN
BALTIMORE · DENVER · ORLANDO

heads cover the frequency range from 100 to 16,000 mc. Power output varies from 500 mw to 5 mw over this frequency range. **Circle 386 on Reader Service Card.**



F-M Radio Terminal
compact unit

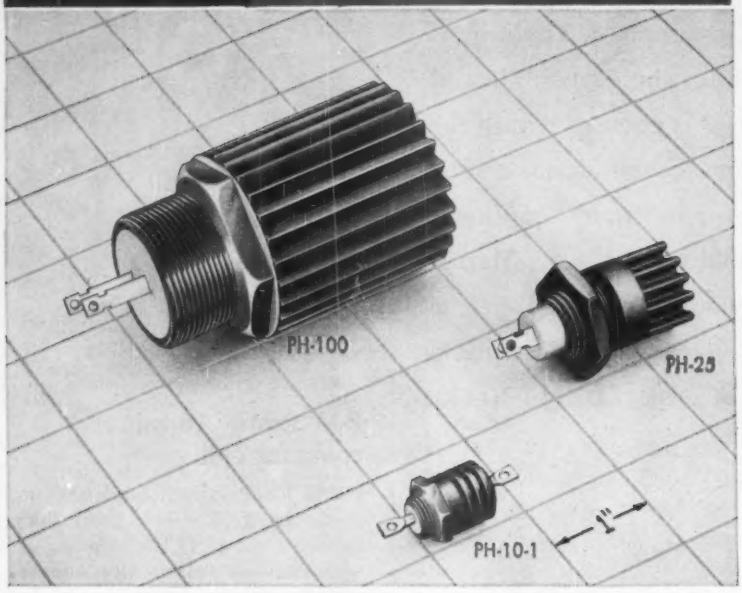
RADIO ENGINEERING LABORATORIES, INC., 29-01 Borden Ave., Long Island City 1, N. Y. Up to six simultaneous toll-quality conversations from suitable multiplex equipment may be handled by the type 896 f-m radio terminal. Transmitter, receiver, and power supply are housed in a single relay rack-mounted enclosure only 35 in. high and weighing but 110 lb. Frequency range is normally 148-174 mc; transmitter power, 50 w; radio gain, 119 db, receiver noise figure, 7 db. **Circle 387 on Reader Service Card.**

Rack Cabinet
for variety of uses

FALSTROM CO., 301 Falstrom Court, Passaic, N. J. The FT-192 is a standardized rack cabinet of

DALOHM Ω

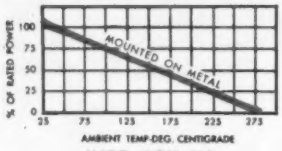
...for Complete Reliability Under Severe Environmental Conditions



TYPE PH POWER RESISTORS

Wire Wound, Precision, Miniature, Ruggedized

TYPICAL DERATING CURVE



JUST ASK US

The DALOHM line includes precision resistors (wire wound and deposited carbon); trimmer potentiometers; resistor networks; collet fitting knobs and hysteresis motors designed specifically for advanced electronic circuitry.

If none of the DALOHM standard line meets your needs, our engineering department is ready to help solve your problem in the realm of development, engineering, design and production.

Just outline your specific situation.

DALE PRODUCTS INC.
1300 28th AVE.
COLUMBUS, NEBRASKA

Designed for primary application of high power requirements, coupled with precision tolerance. Mounts through hole in chassis for maximum heat dissipation. Gives reliability under severe environmental conditions.

- Rated at 10, 25 and 100 watts.
- Resistance range from 0.1 ohm to 60K ohms, depending on type.
- Tolerance: ±0.05%, ±0.1%, ±0.25%, ±0.5%, ±1%, ±3%.

TEMPERATURE COEFFICIENT: Within 0.00002/degree C.

OPERATING TEMPERATURE RANGE: −55° C. to 275° C.

SMALLEST IN SIZE: ½" x ¾" to 1¾" x 2-31/32"

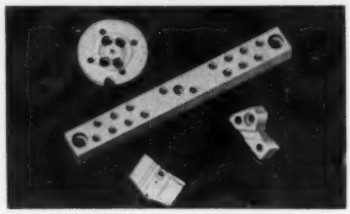
COMPLETE PROTECTION: Sealed in silicone, inserted in radiator finned aluminum housing.

WELDED CONSTRUCTION: Complete welded construction from terminal to terminal.

NEW MOUNTING: Mounted through hole in chassis for maximum heat dissipation.

Visit the Dalohm Booths 2742-44 at the I.R.E. Show

formed construction and designed to make possible the use of heavier loads and afford stable anchoring points for components and chassis. Among its special uses are applications for blower and filter assemblies. The blower system is designed so that filtered air enters the lower portion of the cabinet, circulates and cools components throughout all points within the cabinet and is exhausted at a specially designed vent at the top. **Circle 388 on Reader Service Card.**



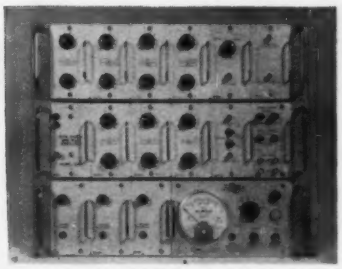
Ceramoplastic operates to 1,550 F

MYCALEX CORP. OF AMERICA, Clifton, N. J., has produced a new machinable insulation material, Supramica 620 ceramoplastic, which will operate at temperatures up to 1,550 F with complete dimensionable stability. Such temperature resistance puts it within the same broad temperature range as ceramic materials such as aluminum and steatite which are relatively harder to machine. Its fine and uniform texture enable it to be machined to most exacting tolerances, even to one ten-thousandth of an inch. **Circle 389 on Reader Service Card.**

Permanent Magnets for twt's

THE INDIANA STEEL PRODUCTS CO., Valparaiso, Ind., announces new Indox VI permanent magnets with application in traveling wave tubes. Indox VI can be used where greater resistance to demagnetizing fields is required or where magnet length is limited as compared to its area. Typical properties include a coercive force of 2,550 oersteds, a residual reduction of 3,200 gauss, and a peak energy product of 2.4×10^6. Made of barium-iron oxide oriented in the direction of pressing, Indox

VI makes possible substantial savings in both material and space for microwave applications. **Circle 390 on Reader Service Card.**



Pulse Generators
transistorized

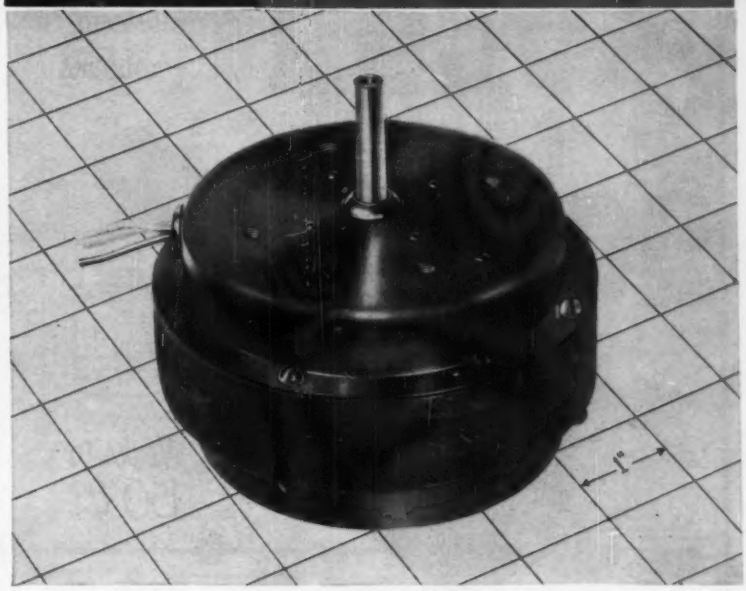
ELECTRO-PULSE, INC., 11861 Teale St., Culver City, Calif. The 5600 series complex digital pulse code generators, for pcm control system development, are fully transistorized and feature plug-in printed wiring modules for flexibility. Equipment is available from 2 to 6 digitally positioned sync outputs in each cycle, which may be arbitrarily connected to 1 to 3 digital triple pulse code group generators. **Circle 391 on Reader Service Card.**

Micromicroammeter
23 ranges

MILLIVAC INSTRUMENTS DIVISION of Cohu Electronics, Inc., Box 997, Schenectady, N. Y. Model MV-11D is capable of d-c current measurements from 10 $\mu\mu$a to 10 amperes. All ranges are left zero, no biasing to a mid-zero is required. Only one range selector switch is used. Polarity indication is controlled

DALOHM Ω

announces NEW BREAK-THROUGH IN HYSTERESIS MOTOR DESIGN



HEAT RISE BARRIER IS LOWERED TO ONLY 20° - 38° C., DEPENDING ON H.P. RATING

Sub-Fractional • Low Noise • No Vibration • Synchronous

The new DALOHM Hysteresis motor provides all the desirable characteristics of such motors, yet doesn't have the usual heat rise handicaps. Small and lightweight, its new pancake configuration is space saving.

- Low noise
- Maintains synchronous speed at rated load
- No vibration or magnetic strays
- Reaches full RPM in 1 revolution
- Exceptionally low cost
- Operates on any frequency up to 120 c.p.s., giving an infinite selection of speeds up to 3600 RPM

RUNNING TORQUE: 2.8 inch/oz. to 28 inch/oz.

VOLTAGE: 115 V., 60 c.p.s.

SPEED: 1800 RPM

Visit the Dalohm Booths 2742-44 at the I.R.E. Show

Ideally suited for facsimile machines, Hi-Fi turntables, tape recorders, tele-metering and many other types of equipment where constant synchronous speed is essential.

JUST ASK US

The DALOHM line includes precision resistors (wire wound and deposited carbon); trimmer potentiometers; resistor networks; collet fitting knobs and hysteresis motors designed specifically for advanced electronic circuitry.

If none of the DALOHM standard line meets your needs, our engineering department is ready to help solve your problem in the realm of development, engineering, design and production.

Just outline your specific situation.

DALE PRODUCTS INC.
1300 28th AVE.
COLUMBUS, NEBRASKA

SPECTROL PRECISION POTENTIOMETERS

tough new original

*Solves Hi-temp Problems

*Works to 150°C!

INTRODUCING THE SPECTROL
METAL MULTI-TURN PRECISION POT

Another example of creative engineering from Spectrol, the new Model 590 10-turn pot features machined aluminum construction with the helical coil placed directly against the case for maximum heat dissipation. You can expect a longer operating life at higher ambient from the Model 590.

Non-hygroscopic aluminum case furnishes excellent dimensional stability

The new pot operates in a relative humidity of 95% over a temperature range of −65 to +150°C. It functions above 20g vibration from 55 to 2000 cps, withstands a 30g shock, and meets all specifications to an altitude of 30,000 feet.

Now in production, the new 590 is available in ranges from 25 to 120,000 ohms. Standard linearity tolerance is ±0.3% with 0.025% on special order. Featuring fused-glass sealed terminals flashed with precious metal, the unit can be supplied with as many as 48 terminals. Both ends of the shaft are supported by ball bearings. The 1" diameter unit is also available with non-linear functions.

Your nearby Spectrol sales engineering representative will be glad to provide complete technical information or you may write directly to Dept. 183

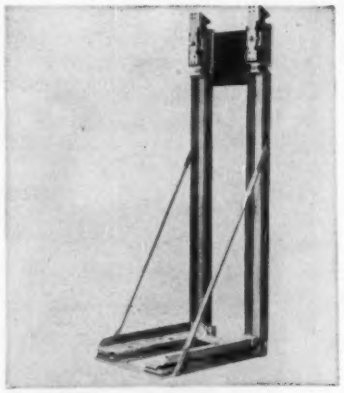
SPECTROL ELECTRONICS CORPORATION
"precision electronic components"
1704 South Del Mar Avenue, San Gabriel, Calif.

See the Model 590 in Booth 3064 at the New York IRE show.

by a plus-minus switch, eliminating lead changing. An amplifier output provides 2.5 v at 0.5 ma for full scale deflection on any of 23 ranges. **Circle 392 on Reader Service Card.**

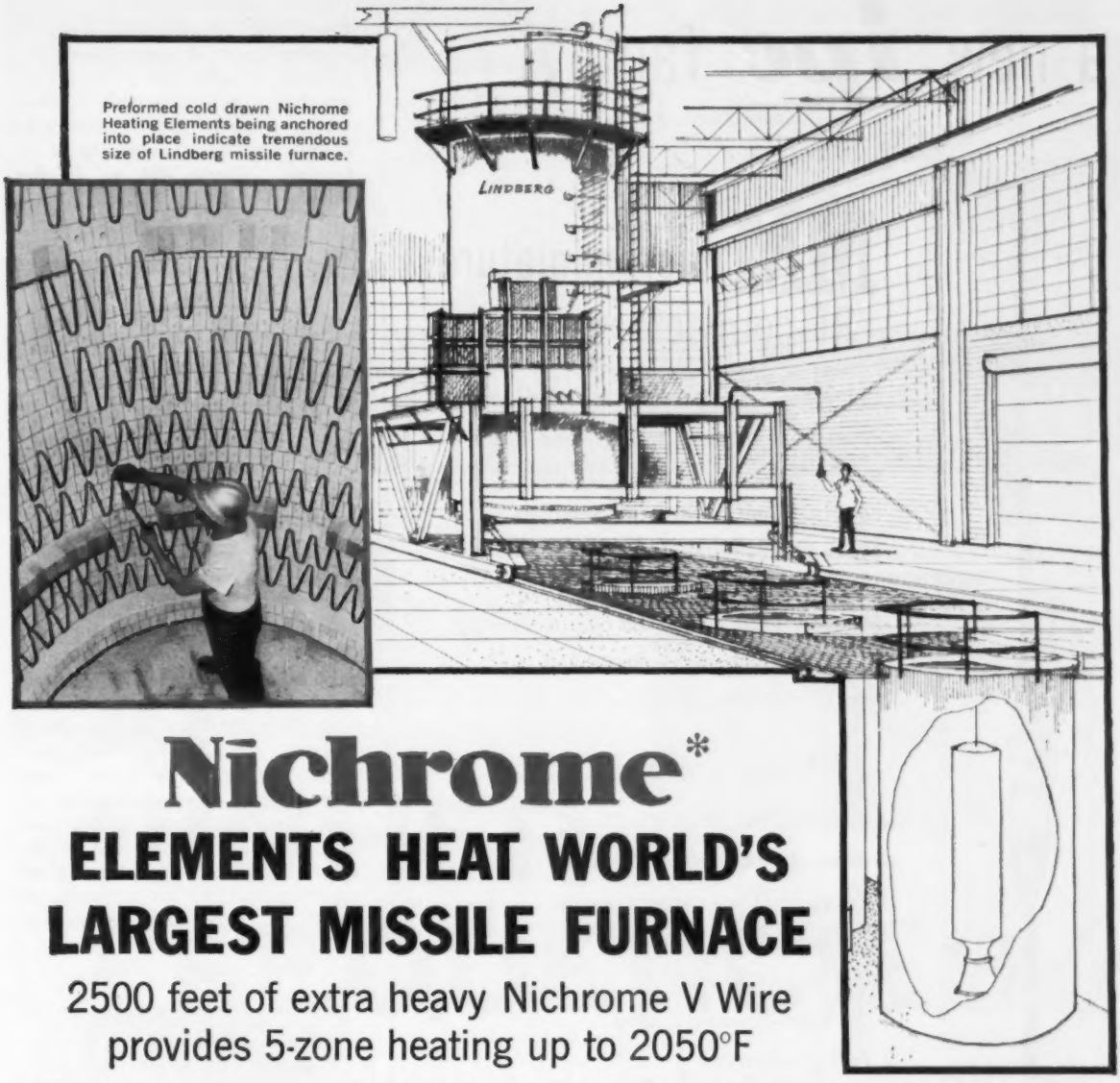
Tv Battery silver-cadmium

YARDNEY ELECTRIC CORP., 40-50 Leonard St., New York, N. Y., announces the maintenance-free Silcad battery for powering completely portable tv sets. The silver-cadmium battery is a 12-v, 5-ampere hour power package weighing 3½ lb, which has already been recycled as many as 200 times. It combines the high power output of silver with the long life of cadmium. **Circle 393 on Reader Service Card.**



Mounting System all-metal

ROBINSON AVIATION, INC., Teterboro, N. J., has developed an all-metal resilient mounting system designed to protect a 975 lb Naval shipboard radio transmitter from destructive shock and vibration. For maximum protection within the shipboard vibration spectrum, the model W583 is comprised of a l-f dual stage base and a twin stabilizer unit. The special orienta-



Preformed cold drawn Nichrome Heating Elements being anchored into place indicate tremendous size of Lindberg missile furnace.

Nichrome*

ELEMENTS HEAT WORLD'S LARGEST MISSILE FURNACE

2500 feet of extra heavy Nichrome V Wire provides 5-zone heating up to 2050°F

This giant 500 KW gantry type Lindberg† hardening furnace is the newest and largest ever built to meet the most exacting heat treating requirements of today's, and tomorrow's, missile metals. It accommodates an effective work load nearly 7 ft. in diameter and 24 ft. long.

Now in operation at Lindberg Steel Treating Company's Melrose Park Plant, the controlled atmosphere installation is both bottom loading and bottom quenching. The 19′ by 57′ pit—28′ deep, beneath the towering electrically heated furnace, houses the loading station, 2 quench tanks (atmosphere and salt) and water wash tank. Work loads pass from furnace to quench through an airtight seal, permitting complete control and precise duplication of atmospheres and treating cycles.

In the hardening furnace there are five control zones which operate between 250°F and 2050°F. Saturable core reactors automatically vary the voltage to the Nichrome*V heating elements between 2.2 and 220 volts, depending on temperature and load.

The selection of Nichrome V by Lindberg to supply reliable and closely controlled heat and temperature in this furnace is further evidence of the confidence that industrial leaders have in the quality and performance of Driver-Harris high-nickel alloys. Why not benefit from their experience. Tell us about your requirements. *T.M. Reg. U.S. Pat. Off. †Lindberg Engineering Company

DRIVER-HARRIS* COMPANY

HARRISON, NEW JERSEY • BRANCHES: Chicago, Detroit, Cleveland, Louisville

Distributor: ANGUS-CAMPBELL, INC., Los Angeles, San Francisco • In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

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a new ipc family!

MM microminiature
RF connectors

IPC introduces Series MM—a complete line of microminiature RF connectors available in screw-type and slide-on coupling, and in three impedances: 50, 73 and 90 ohms. Interchangeable with existing subminiature RF's, Series MM connectors offer ten new reliability features which make them well worth interchanging!

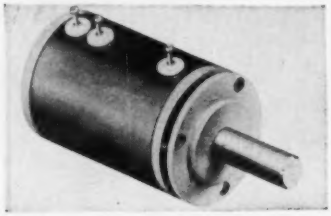
10 New Features

1. *Simplified, Positive Cable Clamp*
2. *Crimped with Standard T & B Tools*
3. *Tough Beryllium Copper Contacts*
4. *Captivated Coupling Nuts*
5. *Captivated Contacts*
6. *Corrosion-Resistant Plating*
7. *Teflon Dielectrics*
8. *Firm Cable Strain Relief*
9. *Exact Electrical Match to RG-/U Cables*
10. *Cable Assemblies, Including Potting*

COME SEE IPC at IRE Booth 2517

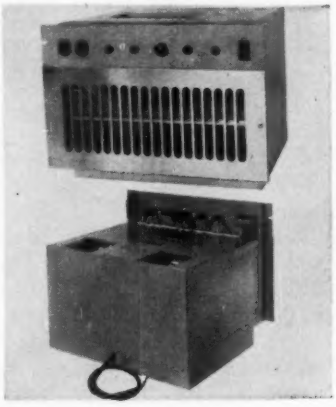
ipc INDUSTRIAL PRODUCTS COMPANY
Danbury, Connecticut
a division of
AMPHENOL-BORG ELECTRONICS CORPORATION

tion of the stabilizer and base with respect to the equipment center of gravity results in a center-of-gravity type suspension system which reduces rocking modes to simple translational modes of vibration. **Circle 394 on Reader Service Card.**



Ten-Turn Pot high temperature

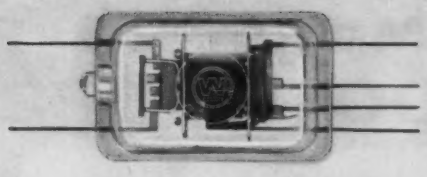
SPECTROL ELECTRONICS CORP., 1704 S. Del Mar Ave., San Gabriel, Calif., announces a new all-metal precision multiturn potentiometer. Capable of withstanding temperatures of 200 C, the model 590 ten-turn pot is available in ranges from 25 to 120,000 ohms. Standard linearity tolerance is ±0.3 percent. Tolerances to ±0.025 percent are available on special order. Unit functions above 20 g vibration from 55 to 2,000 cps, withstands a 30 g shock and meets all specifications to an altitude of 30,000 ft. **Circle 395 on Reader Service Card.**

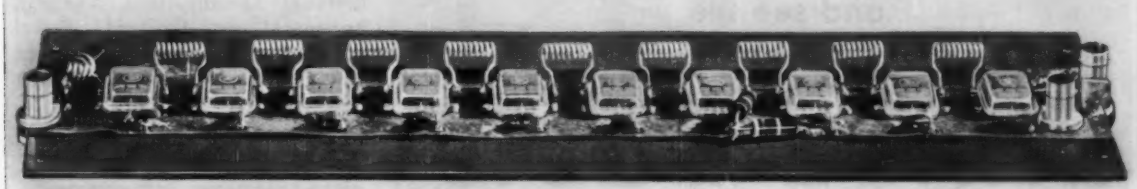


Blower and control panel

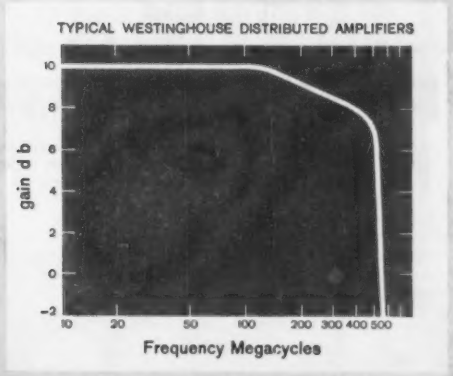
MCLEAN ENGINEERING LABORATORIES, INC., Princeton, N. J., announces blowers equipped with

Westinghouse tube engineering... serving the nation through imagination





GAIN AT HIGHER FREQUENCIES



with Westinghouse distributed amplifiers

The new Westinghouse Match Box Tubes provide distributed amplifiers with response to 550 MC.

Match Box tubes surpass conventional tubes in high frequency performance and resistance to vibration. Tubes lie flat . . . no height problem . . . eliminates sockets, fits printed circuits.

Westinghouse Distributed Amplifiers can be designed with various frequency pass bands. They're especially suited for electronic counter-measure circuits and for high-speed, high-frequency oscilloscopes. We'd welcome the opportunity to design and build your Distributed Amplifiers.

CHARACTERISTICS WX3683

Heater 6.3 Volts	0.2 amperes
Plate current	8 milliamperes
Transconductance	5100 micromhos
Plate Voltage	180 volts

Write for complete information.

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Electronic Tube Division Elmira, N. Y.

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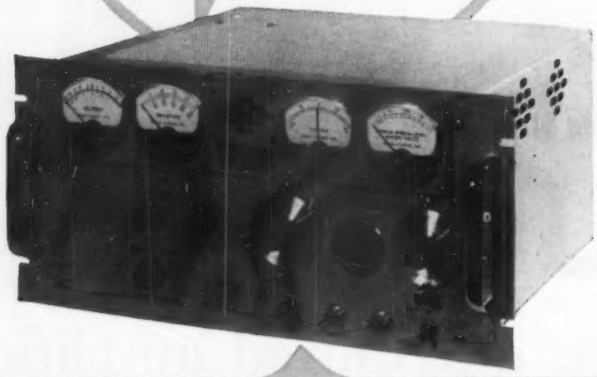

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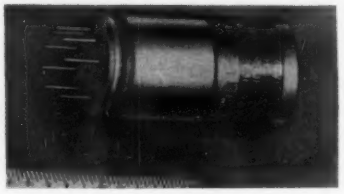
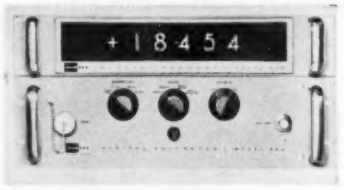
electronic control panels. The panels have appliance outlets and are equipped with circuit breakers and pilot lights. Two models are available: (1) a double outlet unit with a high-speed, quiet, air delivery of 800 cfm and a low-speed delivery of 600 cfm; and (2) a single outlet unit with a single speed of 1,200 cfm. The air discharge design can be built to individual specifications, vertical, horizontal or diagonal. Panel depths are 10¾ in. and 14 in. to fit 19 in. racks. **Circle 396 on Reader Service Card.**



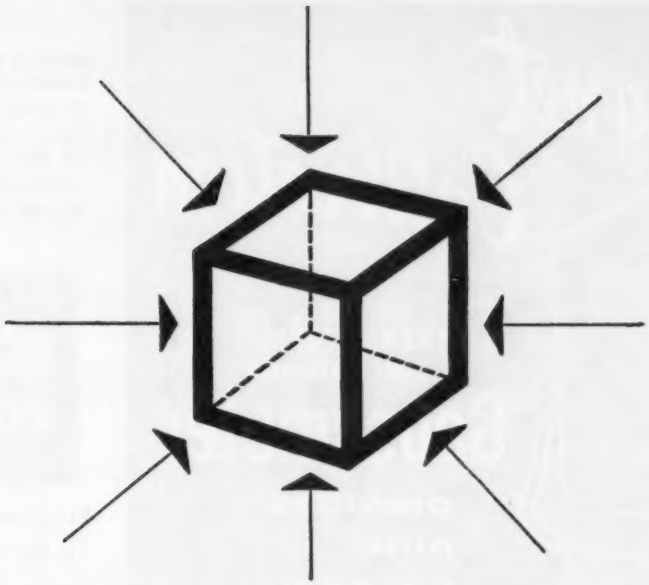
Chopper subminiature

THE BRISTOL CO., Waterbury 20, Conn. Excellent tracking and resistance to shock and vibration are characteristic of a subminiature dpdt Syncroverter chopper. Unit is designed for high reliability and long life. Contact rating from dry circuit to 100 v and phase angle which is virtually unaffected by temperature extremes from −65 C to + 125 C are feautres. **Circle 397 on Reader Service Card.**



Digital Voltmeter over-ranging

KIN TEL, a division of Cohu Electronics, Inc., 5725 Kearny Villa Road, San Diego 12, Calif. Model 501 over-ranging d-c digital voltmeter measures from 0.0001 to 1,000.0 v d-c with 0.01 percent ±1 digit accuracy. Features include: continuous automatic calibration



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- Semi-conductors
- And a lot of others

Right now—today at Burroughs: plenty of room for exceptional engineers to help create the *successors* to Burroughs' big line of advanced electronic and electro-mechanical data processing equipment. Equipment that ranges from giant electronic computer systems to automatic accounting machines and more.

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Men who can get the most out of our heavily budgeted research facilities.

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Men who are frankly interested in increased responsibility. In swift promotion in careers that offer a wide choice of location. And, yes, in money.

Are you as outstanding as these opportunities? Then outline your education and experience as briefly or fully as you wish, name the field you'd like to help us explore, and get that information to A. L. Suzio, Administrator, Corporate Placement Services, Dept. 101-A, Burroughs Corporation, Detroit 32, Mich.

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"NEW DIMENSIONS / IN ELECTRONICS AND DATA PROCESSING SYSTEMS"

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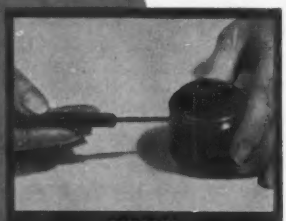
TRANSISTORIZED
DIRECT READING
Gaussmeter
provides nine full-scale ranges

MODEL 1295A

RANGES (Gauss)		
0-100	0-1000	0-10,000
0-200	0-2000	0-20,000
0-500	0-5000	0-20,000 plus

This stable, all transistorized Gaussmeter operates on the Hall Principle and provides a conservative accuracy of ±3% over-all ranges. Accuracy can be increased to ±1% at any point between 500 and 20,000 gausses by use of special probe reference magnets. Response is flat when measuring magnetic fields from DC up to 120 cps. Correction curves are supplied for measurement of fields up to 400 cps.



TYPICAL REFERENCE MAGNET

Unit is supplied with a 1000-gauss ±¾% probe reference magnet and one standard probe. Nominal probe thickness is 0.025". An ultra-thin probe, measuring 0.007" is available on special order. Sensitive element area of probes is approximately 0.017 square inches.

Probe Reference Magnets

The Model 1295A Gaussmeter operates from 115-volt, 50-400 cycle power line. Internal switching arrangement and battery holders are also provided for self-contained battery operation. Compartment in back of aluminum case provides storage for probe, reference magnet and power cord. Over-all size is 11 x 7 x 12. Weighs 12 lbs. Net price $420. complete.

Prices are f.o.b. Boonton, N.J. & subject to change without notice.

SEND FOR TECH. DATA

For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

Radio Frequency LABORATORIES, INC.
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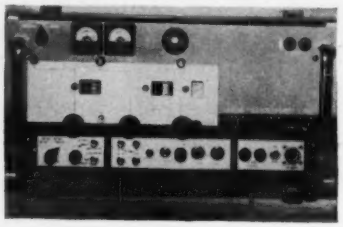
against an internal standard cell; automatic ranging and polarity indication. Single plane, projection type readout presents numerals on clear in-line display with no overlapping characters. **Circle 398 on Reader Service Card.**



Frequency Meter
10 kc to 3,000 mc

LAVOIE LABORATORIES, INC., Morganville, N. J. A "new-look" version of model LA-70 vhf frequency meter has a range of 10 kc to 3,000 mc. Unit is accurate to 1 part per million over a range of 20 mc to 3,000 mc, and reaches full measuring accuracy with only a 20-minute warmup. **Circle 399 on Reader Service Card.**

Rosin Flux
highly resistive

ALPHA METALS, INC., 56 Water St., Jersey City 4, N. J. Alpha 610 is an activated rosin flux that leaves unusually resistive residue after heating—features of prime importance in circuitry soldering. In its raw state it has relatively low conductivity. During soldering, the rosin's conductive constituents are destroyed. The flux also features instant wetting, excellent capillary action and a moderate drying rate. **Circle 400 on Reader Service Card.**

Crystal Oven
precision unit

ROBERTSHAW-FULTON CONTROLS Co., 911 E. Broad St., Richmond 19, Va., is unveiling its latest model precision crystal oven. Among the unit's significant advantages are low power consumption, no noise generation, constant lead capacity, long term stability, and cavity temperature variation less than

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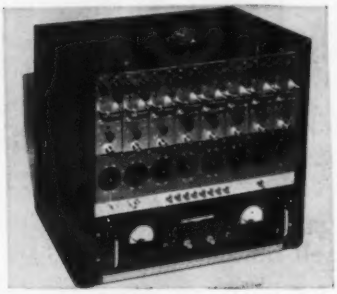
330 West 42nd Street

New York 36, N. Y.

0.01 C average per deg ambient temperature change. Applications include equipment using crystal oscillator circuits or temperature sensitive components. **Circle 401 on Reader Service Card.**

Epoxy Resin Systems protective coating

PERMACEL, New Brunswick, N. J., announces PRH400 and PRH401 epoxy resins. PRH 400 is a solvent based epoxy system and is recommended for use as a protective coating for printed circuits and other electronic components. It is excellent as a surface primer prior to potting or encapsulating with other epoxies. PRH401 is a single component system, of 60 percent solids content. It is a fluid, heat-curing, solvent-based epoxy system recommended for use in adhesive for metals, or impregnating of coils. **Circle 402 on Reader Service Card.**



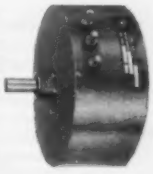
Signal Simulator eight channels

HALLER, RAYMOND, AND BROWN, INC., Science Park, State College, Pa. The signal environment simulator generates a realistic high density signal environment in the 200 to 350 mc band, L-band or S-band. This unit simulates 8 non-voice radiators, each tunable over a 100-mc range. On each of the 8 channels, azimuth bearing of the

...and now for a spot of welding!

Still at it? Trying to improve potentiometer reliability by building 'em yourself? Well, you're on the right track about *one* thing — welding's a sure way to eliminate a lot of operational headaches — like gassing contamination of contact metals at high temperature, from organic solder flux. No chance of "cold joints", either, to increase circuit resistance. No soldered connections to come loose under vibration and shock. Welding *is* the way to reliability!

But why set the wife's drapes afire to get a reliable, all-welded pot? Utilizing welding techniques, Ace produces reliable potentiometers operable at temperatures exceeding 150°C. and able to withstand 50 G's at 2000 cycles. All this, plus extremely low contact resistance and longer rated life. All taps, end connections, resistance elements, contact assemblies and terminal leads are specially prepared beforehand — then welded with pure nickel or palladium silver. So, for built-in reliability through sounder construction techniques, see your ACErep!



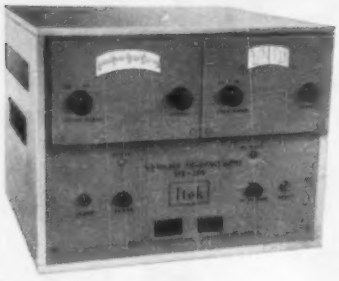
This 2" AIA Acepot® (shown ½-scale) incorporates all these exclusive welding construction features, for superior reliability.

ACE ELECTRONICS ASSOCIATES, INC.
99 Dover Street, Somerville 44, Mass.
SOmerset 6-5130 TMX SMVL 181 West. Union WUX

Acepot® Acetrim* Aceset® Aceohm® *Reg. Appl. for

VFS 300 at the I.R.E. Show

SEE IT FOR THE FIRST TIME AT BOOTH #3220



THE NEW Itek
VFS 300
VARIABLE
FREQUENCY
POWER SUPPLY

THIS NEW COMPACT PORTABLE UNIT PROVIDES . . .

Output Power—250 volt-amperes continuous and 300 volt-amperes intermittent.

Output Frequency—45 to 2000 cycles alternating current.

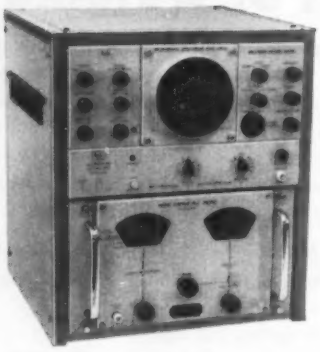
Output Voltage—0-140 volts rms, continuously variable.

It is completely self-contained and operates with 105-130 volt AC 50-60 cycle input. Available for bench or field use or for rack mounting.

For TESTING
airborne electronic and electrical systems, servo amplifiers, synchro and selsyn systems, transformers, inductors and export equipment.

For POWERING choppers, vibrators, vibration shakers and magnetic amplifiers.

For CONTROLLING synchronous motors and processing equipment.

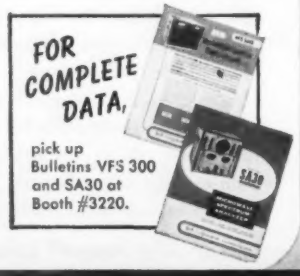


MODEL SA30
MICROWAVE
SPECTRUM
ANALYZER

For the frequency range of 2000 mc/s to 38.6 kmc/s . . .

to determine the power, the characteristics and the frequency distribution of pulsed and CW microwave signals.

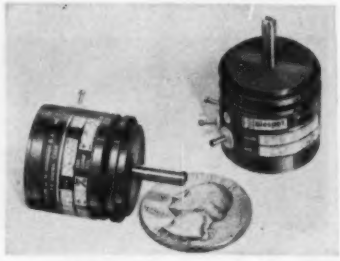
This highly sensitive precision test instrument is recommended for use in design, manufacture, test, installation and maintenance of microwave, radar, altimeter, guided missile or television relay communication and control equipment. Available with fully interchangeable RF Heads to cover the entire band from 2000 mc/s to 38.6 kmc/s.



Itek Corporation

1609 Trapelo Road, Waltham 54, Mass.

simulated arriving signal is arbitrary and adjustable. Various antenna patterns may be used on each channel. **Circle 403 on Reader Service Card.**



Potentiometer subminiature

G. M. GIANNINI & CO., INC., 918 E. Green St., Pasadena 1, Calif. Model 875 precision pot weighs only ⅛ oz, measures 0.875 in. in diameter and features linearity to ±0.1 percent of full scale. It offers a resolution as high as 0.06 percent. Resistance ranges from 200 ohms through 100,000 ohms per section are available. Unit is wire wound, has servo mount, and up to 4 sections can be ganged on a common shaft. A sine-cosine version is also available. **Circle 404 on Reader Service Card.**

Servo Instruments self-balancing

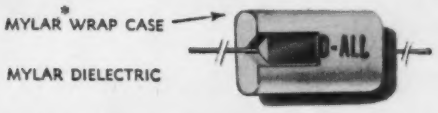
NORTH ATLANTIC INDUSTRIES, INC., 603 Main St., Westbury, N. Y. Measurement of total air temperature for aircraft flight testing is one of the applications of the new series of self-balancing servo instruments now being introduced. The system, which uses off-the-shelf building-block elements to provide customized designs for particular requirements, can also be used as a ratiometer, millivoltmeter, tachometer or data repeater for telemetry. Air temperature

A Leading Manufacturer of Tubular, Ceramic Disc and Electrolytic Capacitors

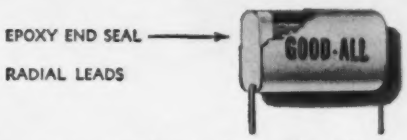
Good-All CAPACITORS

New, flat shape invites "crowding"

663 F.. for Terminal Board assembly



663 FR .. for Printed Circuit Boards



These special-purpose versions of popular Good-All Type 663UW offer great flexibility in fitting capacitance into tight spaces. They are conservatively rated and provide the same dependability and electrical ruggedness that has made the 663UW tubular a "standard of quality" for both military and instrument-grade equipment.

*DuPont's trademark for polyester film.

SPECIFICATIONS

TEMPERATURE RANGE—Full rating to 85°C; to 125°C with 50% derating.

LIFE TEST—250 hours at 85°C and 125% of rated voltage.

VOLTAGE RANGES—100, 200, 400 and 600V DC.

CLOSE TOLERANCES — Available in tolerances to ±5%.

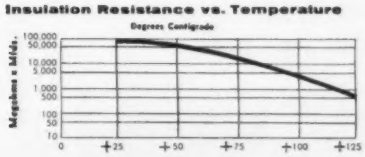
INSULATION RESISTANCE—See I.R. versus temperature curve below.

DIELECTRIC STRENGTH—Twice rated voltage for 1 minute.

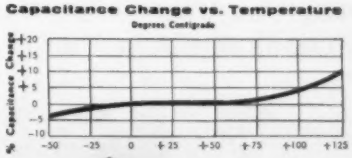
TYPICAL SIZES SHOWING THICKNESS - WIDTH - LENGTH

CAPACITANCE IN MFDS.	100 VOLTS T	W	L	200 VOLTS T	W	L	400 VOLTS T	W	L	600 VOLTS T	W	L	1,000 VOLTS T	W	L
.001	.062	3/16	1/2	.062	3/16	1/2	.062	3/16	1/2	.062	3/16	1/4	.125	1/4	3/4
.0047	.062	3/16	1/2	.062	3/16	1/2	.093	7/32	1/4	.125	1/4	3/8	.156	5/16	7/8
.01	.062	3/16	1/2	.062	3/16	1/2	.140	1/4	3/4	.203	5/16	3/8	.234	5/16	3/8
.022	.093	7/32	3/4	.140	1/4	3/4	.203	3/8	3/4	.234	3/8	3/8	.218	15/64	1 1/16
.047	.125	1/4	3/4	.156	5/16	3/4	.218	15/64	7/8	.281	15/64	1	.343	11/32	1 1/16
.1	.156	5/16	1/2	.234	1/4	7/8	.250	1/2	1	.312	19/64	1 3/16	.359	13/64	1 1/16
.33	.187	3/8	1	.250	1/2	1 1/16	.343	25/64	1 1/16	.468	3/4	1 1/16	.500	1 1/32	1 3/16
.47	.281	3/8	1 1/16	.340	23/64	1 1/16	.437	7/16	1 1/16	.531	1 1/32	2	.765	1 3/16	2
1.00	.359	3/8	1 1/2	.437	15/64	1 3/4	.500	1 1/16	2	.796	1 1/2	2 1/2	.859	1 5/16	2 5/8

Insulation Resistance vs. Temperature



Capacitance Change vs. Temperature



Write for literature on these NEW, "space-saving" types

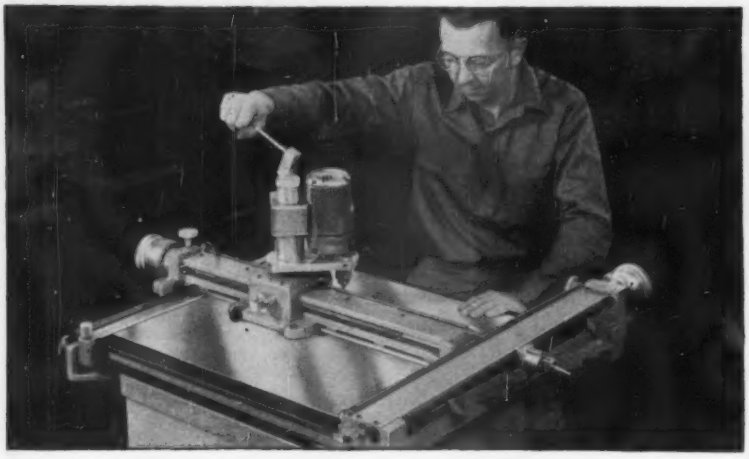
SEE US AT BOOTH #3716—IRE SHOW

GOOD-ALL ELECTRIC MFG.CO.

OGALLALA, NEBRASKA

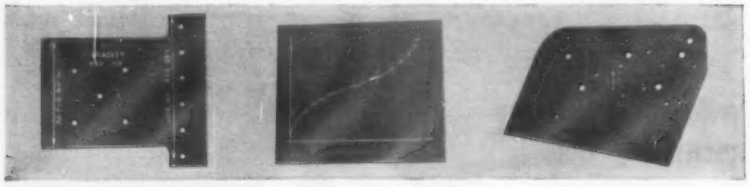
IN CANADA: 700 WESTON ROAD • TORONTO 9, ONTARIO

layout and template making time cut in half...



THE NEW STRIPPIT FLEX-O-DRILL

- **DRILLS, REAMS, SCRIBES, CENTER PUNCHES** to ± 0.002" WITHOUT base line drawing or height gauge layout!
- **EASY, ACCURATE POSITIONING**—quickly set to any reference point and to nearest 0.100" by adjustable steel tapes reading in both directions from zero. Micrometric gauges then bring settings to nearest 0.001". No optical scanning device needed.
- **LASTING ACCURACY!** Table is an actual ground surface plate. Bridge assembly is of heavy, accurately machined castings. Lead screws are precision ground and engaged only during micrometric gauge settings to minimize wear. All parts are corrosion-resistant. Bearings are protected against dust and chips by felt shields. Drill motor is heavy-duty industrial type.
- **¼" CAPACITY** in mild steel — stock up to 24" width, any length.
- **ALSO A PROVEN MONEY-SAVER** on pilot runs, low unit production.



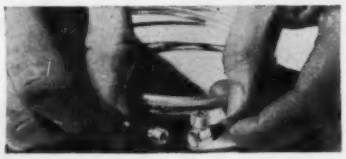
Template drilled by Flex-O-Drill | *Layout scribed by Flex-O-Drill* | *Flex-O-Drill work piece*

WRITE FOR LITERATURE TODAY, and an actual demonstration at your plant:

WALES STRIPPIT INC.
225 Buell Road, Akron, New York
In Canada: Strippit Tool & Machine Company, Brampton, Ontario

A UNIT OF HOUDAILLE INDUSTRIES, INC.

probe shown with the system (on p 192) is Rosemount Engineering Co. model 102. **Circle 405 on Reader Service Card.**

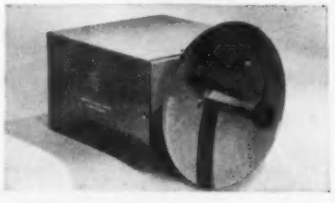


R-F Connectors microminiature

IPC DIVISION of Amphenol-Borg Electronics Corp., Danbury, Conn. Series MM, a complete line of crimp-type microminiature r-f connectors, is announced. Initial release is comprised of plugs, jacks, bulkhead jacks, right angle plugs, hermetically sealed receptacles, bulkhead adapters, bulkhead receptacles, p-c receptacles and caps in screw-on and slide-on coupling. Three impedances—50, 70 and 93 ohms—match standard subminiature RG-/U coaxial cables. **Circle 406 on Reader Service Card.**

Ferrite Material for 50-200 mc range

GENERAL CERAMICS CORP., Keasbey, N. J., has developed the Q-3 ferrite material for application in the 50 to 200 mc range. It is a temperature-stable material with a total permeability change of not more than ±3 percent over a temperature range of −65 C to +80 C. Applications include filters, loading coils and other electronic components requiring extreme stability and high Q at frequencies in the 100 kc region. **Circle 407 on Reader Service Card.**



X-Band Antenna rotating feed

CALIFORNIA TECHNICAL INDUSTRIES, division of Textron Inc., 1421 Old

NOW, FROM FAIRCHILD

PNP SILICON MESA TRANSISTORS

A "MIRROR IMAGE" OF AVAILABLE NPN CHARACTERISTICS

Same high-speed switching capabilities with which Fairchild startled the industry are now available in PNP – 80 milli-micro-second rise time, 2 watts dissipation, 300° C. survival. Fairchild Silicon Transistors are multiple solid-state diffused. Their mesa construction affords excellent heat dissipation and extraordinary ruggedness.

Complementary symmetry within computer circuit designs now affords another technique for reducing number of components and increasing reliability. The advantages of complementary symmetry have been well known, but the high performance silicon transistors that could take advantage of the technique have not been available.

Direct replacement of germanium by silicon is feasible now that high performance silicon PNP mesa transistors are readily available. In silicon transistor circuits, you need no longer hesitate to make use of the particular advantages of PNP polarity. Availability is firmly assured.

COMPETITIVE ADVANTAGES FOR YOUR DESIGNS either in terms of price or functional efficiency are a likelihood that you should investigate. PNP silicon transistors with these speed-power characteristics have not been generally available, hence until now it has not been possible to design circuits using the complementary symmetry concept..

Special attention will be given to inquiries received on company letterhead.

PNP – 2N1131, 2N1132

Symbol	Specification	Rating	Characteristics	Test Conditions
V_{CE}	Collector to Emitter voltage (25° C.)	30v		
P_C	Total dissipation at 25° C. Case temp.	2 watts		
h_{FE}	D.C. current gain		2N1131–15 to 45 2N1132–30 to 90	I_C = 150ma V_C = 10v
R_{CS}	Collector saturation resistance		6Ω typical 10Ω max.	I_C = 150ma I_B = 15ma
h_{fe}	Small signal current gain at f=20Mc		2.5 typical	I_C = 50ma V_C = 10v

NPN – 2N696, 2N697

Symbol	Specification	Rating	Characteristics	Test Conditions
V_{CE}	Collector to Emitter voltage (25° C.)	40v		
P_C	Total dissipation at 25° C. Case temp.	2 watts		
h_{FE}	D.C. current gain		2N696–20 to 60 2N697–40 to 120	I_C = 150ma V_C = 10v
R_{CS}	Collector saturation resistance		3.5Ω typical 10Ω max.	I_C = 150ma I_B = 15ma
h_{fe}	Small signal current gain at f=20Mc		5 typical	I_C = 50ma V_C = 10v

844 CHARLESTON RD. • PALO ALTO, CALIF. • DA 6-6695

FAIRCHILD SEMICONDUCTOR CORPORATION

AUTOMATION

the modern way to cut costs... save time

Latest in Coil Winding Equipment Company's wide variety of high-speed coil winders for all possible needs is the Model CK, designed to take maximum advantage of the time and money saving principles of automation. The Model CK meets most applications, minimizes maintenance, and cuts down considerably on the need for special-purpose, custom-built equipment.

MODEL CK

The Model CK features Coil Winding Equipment Company's recently-developed turret transfer. In combination with a suitable winding head, the ingenious turret transfer permits adding — *only as needed* — hopper feed for the coil forms; stripping, cementing, taping and cutting attachments. The Model CK will produce complete bobbin or single-layer coils without operator attention when equipped with a hopper or magazine for the coil forms and appropriate standard attachments, and it will provide stations for finishing as required.

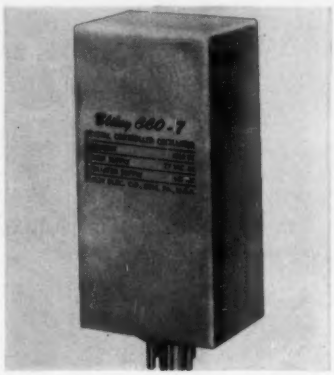
We'll be pleased to send you complete information. Write or phone.

Coil Winding Equipment Co.

OYSTER BAY N.Y. – OYster Bay 6-1285

VISIT BOOTH #4426

County Road, Belmont, Calif. Model 157 X-band variable polarization antenna features motor-driven, remote control of polarization. Stop positions, spaced every 45 deg, are selected by a switch connected to the unit with a 5-wire cable. A mechanical index locates and locks the feedhorn accurately at the selected position. Specifications include: 8,500 to 9,600 mc frequency range; 50 kw nominal peak power handling capacity; 24 db gain. **Circle 408 on Reader Service Card.**



Oscillator
crystal controlled

BLILEY ELECTRIC CO., Union Station Building, Erie, Pa. The CCO-7 oscillator provides precise frequency control in a compact transistorized package. Under adverse operating conditions, the unit has a stability of 4 parts in 10 million. Features include glass sealed crystal unit, printed circuitry and built-in temperature control. The entire unit is hermetically sealed. **Circle 409 on Reader Service Card.**

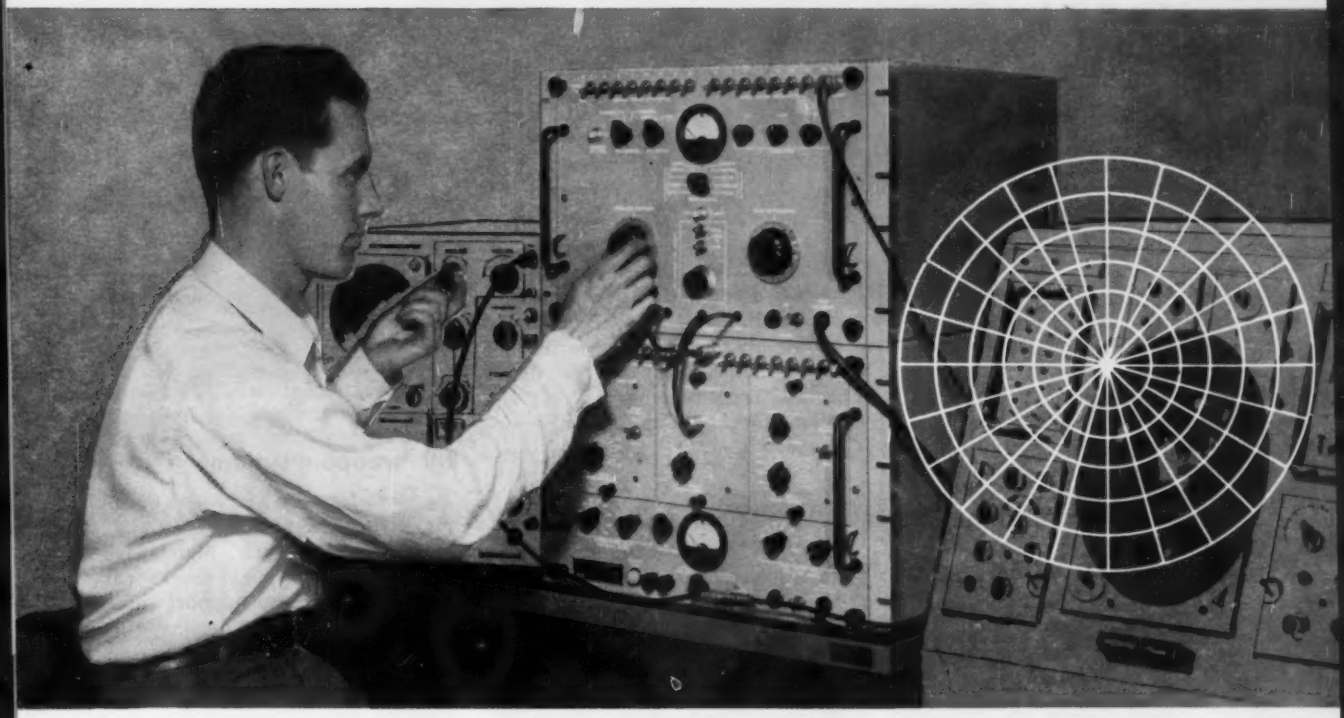
Power Sources
self-contained

SIERRA ELECTRONIC CORP., 3885 Bohannon Drive, Menlo Park, Calif. Model 215 power sources permit accurate calibration of bidirectional power monitors and termination wattmeters. Output power is adjustable from 20 percent to 100 percent of rated power, and tuning is continuous over frequency ranges. Units are self-contained including power supply. Four models cover, respectively,

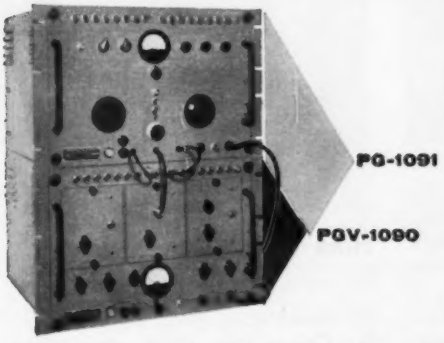
NEW dual purpose
RADAR TEST SET

1 Tests MTI radar for sub-clutter visibility and cancellation ratio.

2 Generates precision video and IF pulses for missile guidance and similar applications.



DWE **PG-1091 meets every military and commercial requirement:**



Model PG-1091 consists of 2 units: IF and video pulse generators, which together measure cancellation ratio and sub-clutter ratio. PGV-1090 (bottom) may be purchased separately for generating a precision video pulse and for checking cancellation ratio.

- LOW SYSTEM JITTER . . . TO WITHIN .0005 μSEC
- FAST PULSE RISE TIME . . . LESS THAN .026 μSEC
- HIGHLY ACCURATE SIMULATED RANGE TO 100 MILES

Primary function: testing and measuring MTI radar sets for cancellation ratio and sub-clutter visibility ratio. Allows a precision adjustment unequalled in any other equipment.

Secondary function: generating precision video and IF pulses for missile guidance and similar applications.

Fully illustrated and described in bulletin DW-104. For your free copy, write Divco-Wayne Electronics, 9701 Reading Road, Cincinnati 15, Ohio.

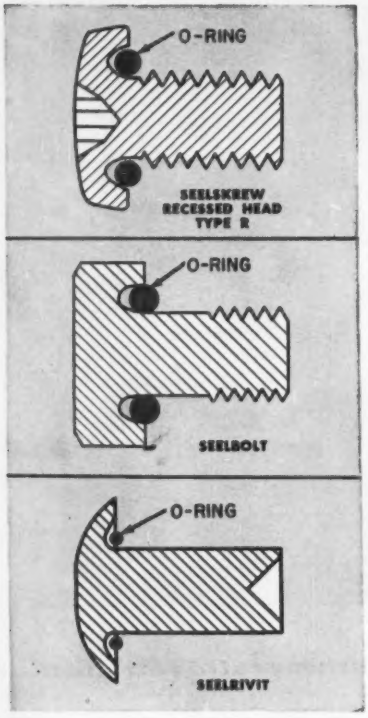
DIVCO **DW** ELECTRONICS

A Division of the Divco-Wayne Corporation

DESIGNERS • ENGINEERS • MANUFACTURERS

Custom built precision mechanical, electro-mechanical and electronic equipment for industry and defense.

SEELSKREWS®
SEELBOLTS®
SEELRIVITS®
High Pressure Self-Sealing
HARDWARE



- Removable and static self-sealing screws, bolts and rivets.
- These industrial fasteners meet all applicable military specifications.

Send for Catalog 359

A.P.M. Corporation
(AUTOMATIC and PRECISION MFG.)
252 Hawthorne Ave., Yonkers, N.Y.
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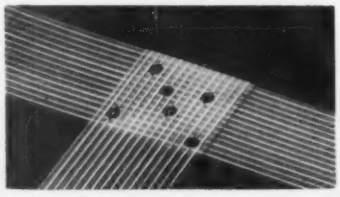
HIGH PRESSURE STATIC AND MOVABLE SEALS
HEXSEALS® • SEELSKREWS® • SEELBOLTS® • SEELRIVITS®
Visit our Booth 3939 at the IRE Show.
CIRCLE 207 READERS SERVICE CARD

25 to 50 mc, 50 to 150 mc, 150 to 470 mc, and 470 to 1,000 mc. **Circle 410 on Reader Service Card.**

Zener Tester direct reading

ELECTRONIC RESEARCH ASSOCIATES, INC., 67 Factory Place, Cedar Grove, N. J. Model DT100 zener voltage tester is intended for both laboratory and factory measurement of zener diodes, transistors, semiconductor rectifiers and similar solid state elements. Unit incorporates a constant current generator which maintains zener or diode current constant independent of diode impedance. Provision is also included for external modulation and a-c readings so that a-c zener impedance can be determined for any zener current setting. **Circle 411 on Reader Service Card.**



Wiring System high-speed

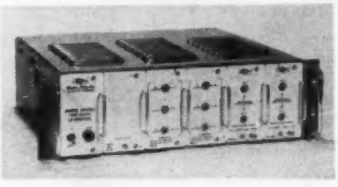
TAPE CABLE CORP., 790 Linden Ave., Rochester 10, N. Y., announces a new system of making harnesses and cable assemblies. Called SELECTACON (from SELECT A CONnection) the method offers cost reduction and eliminates wiring errors and lacing, while increasing reliability and convenience. Based on the phenomenon of a non-carbonizing polyester, SELECTACON wiring assemblies are made by laying one section of Tape Cable on another and soldering the desired conductor intersections through the insulation. **Circle 412 on Reader Service Card.**

Mylar Capacitor for OEM market

PYRAMID ELECTRIC CO., Darlington, S. C., now has available for original equipment manufacturers its Mylar "Gold Standard" capacitor. The new dielectric capacitor, also known as type 111, features a critical capacitance tolerance factor of ±10 percent. **Circle 413 on Reader Service Card.**

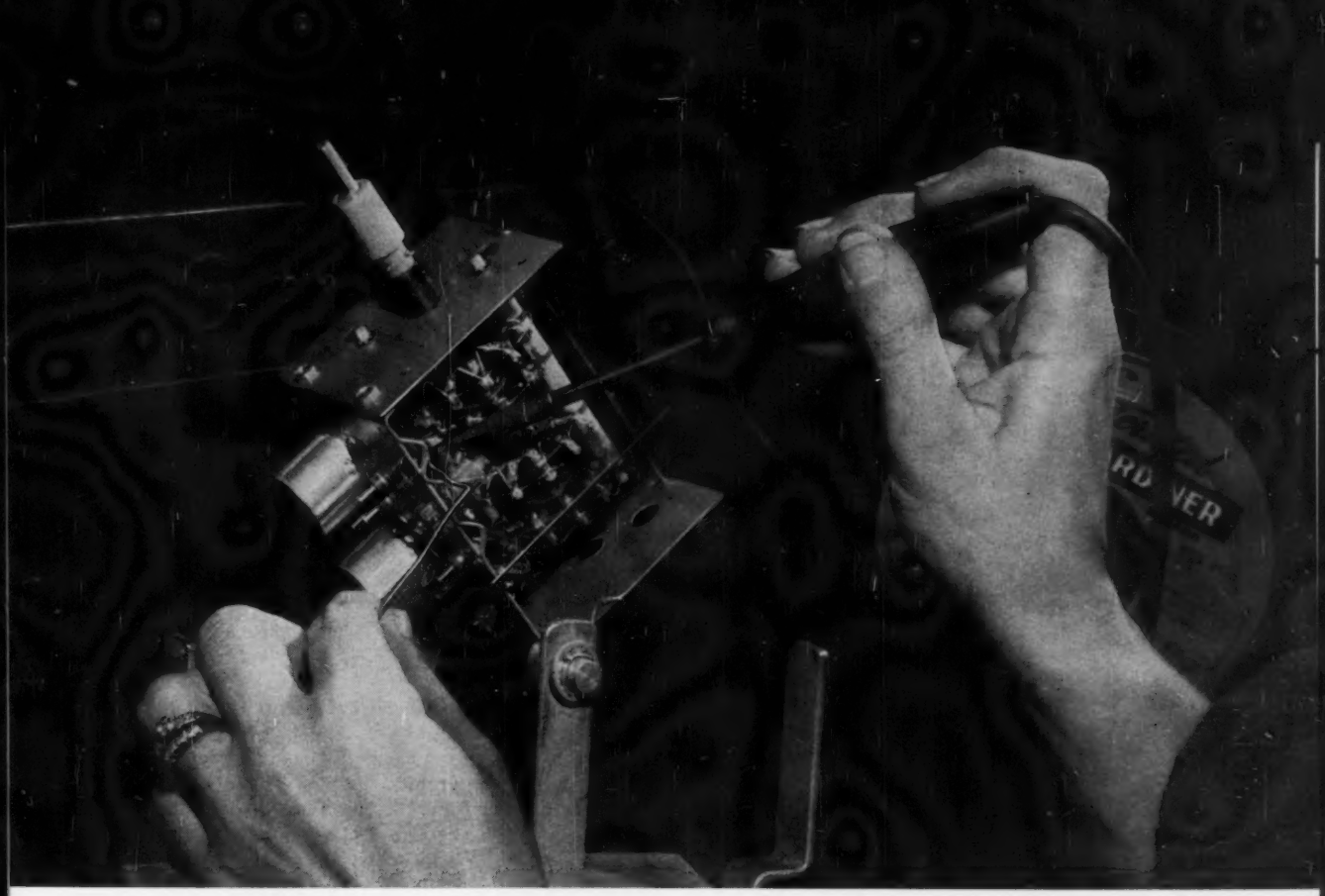
Test Set for weapon systems

PACKARD-BELL CO., 12333 W. Olympic Blvd., Los Angeles 64, Calif., announces automatic, high speed test equipment which checks out Thor missile ground support units, with results visually displayed as GO/NO-GO indications. This unit is part of the multipurpose checkout system being developed by the company for missiles, aircraft and other military weapon systems. **Circle 414 on Reader Service Card.**



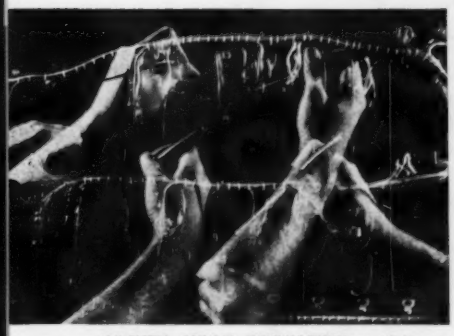
Time Mark Generators for lab use

ELECTRO-PULSE, INC., 11861 Teale St., Culver City, Calif. The 5700 series time mark generators include a unit for generating oscil-



"IT'S SIMPLE ECONOMICS," says Mr. Robert R. Keller, Process Engineer at Sarkes Tarzian Inc., well known electronics components manufacturer in Bloomington, Indiana. "We have an average of 185 General Electric Midget soldering irons in operation on our television tuner assembly lines. We find the G-E Midget iron more efficient than our heavier irons on many operations. Each iron solders an average of 85,000 joints every year. Some irons solder as many as 150,000 joints per year. Compared to maintenance and replacement costs on other soldering irons we have tested and used, we save approximately $57.50 per year on each iron. Our present annual saving with all the G-E Midget irons is about $10,600." Sarkes Tarzian Inc., found that the rugged ironclad copper tips on the Midget last from six to nine months, provide fast, concentrated heat with reduced risk of loosening nearby joints.

Every Year, 185 General Electric Midget Irons Save Over $57 Each At Sarkes Tarzian Company



FASTER HEAT RECOVERY and lower maintenance of G-E soldering irons have been proved by many manufacturers under their own production conditions—along with competitive soldering irons. If you would like to compare General Electric irons with the irons you are now using, call your G-E distributor.

DELIVERY TODAY is now possible on popular soldering irons and other General Electric heaters and devices from a local distributor near your plant. Your replacement inventory may be reduced. For the name of your nearest stocking distributor for G-E heaters and devices, call your General Electric Apparatus Sales Office.

SAVINGS ACHIEVED by several users and information about the construction features of General Electric soldering irons are included in a new bulletin, "Save While You Solder," GED-3553. For a copy, call your G-E distributor or write Section 724-5, General Electric Company, Schenectady 5, New York.

GENERAL ELECTRIC

CIRCLE 208 READERS SERVICE CARD

measure down to

0.03 μv

The Keithley 150 sets a new standard of sensitivity for dc voltmeters. Typical uses include output measurements from strain gages, thermopiles and ion chambers, as well as Hall effect studies, corrosion work and molecular weight analysis.

Functions and measurement spans of the 150 are: dc voltmeter, 1 microvolt to 1 volt full scale; ammeter, 10^{-3} to 10^{-10} ampere full scale; dc amplifier, gains of 10 to 10^{7}; and null detector, with 0.5 to 2 second response. Features include:

- **zero stability** as a voltmeter within 0.1 microvolt per day; as an ammeter, within 2 x 10^{-11} ampere per day.
- **zero suppression** up to 100 times full scale.
- **optional** floating or grounded input.
- **short term noise** within 0.03 microvolt peak to peak (0.006 microvolt RMS).
- **rugged construction,** relative insensitivity to vibration, 60-cycle fields, or thermal EMF's.

Write today for your copy of Keithley Engineering Notes, Vol. 7 No. 1 describing the Model 150.

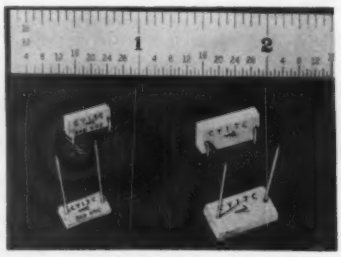
KEITHLEY INSTRUMENTS, INC.
12415 Euclid Ave., Cleveland 6, Ohio

CIRCLE 209 READERS SERVICE CARD

lograph timing marks (10 millisec to 10 sec spacing) and two laboratory time and frequency standard units (10 sec to 100 kc or 1 mc in decades). **Circle 415 on Reader Service Card.**

Recording System
high speed

SANBORN CO., 175 Wyman St., Waltham 54, Mass., announces a new 6- and 8-channel direct writing system for 5-v full-scale recording. The model 356-, 358-5480 is a simplified system without preamplifiers for recording computer output, telemetered signals and similar applications where 0.1 v/div sensitivity is sufficient. Total panel space is under 25 in., for the control panel and the completely transistorized recorder package. The recorder package includes a flush-front recorder, built-in power supply and individual plug-in power amplifiers. **Circle 416 on Reader Service Card.**



Capacitors
radial-lead

VITRAMON, INC., Box 544, Bridgeport, Conn. The new radial-lead CY17C Vitramon capacitor brings capacitance values in the radial series to 1,200 μμf at 50 to 300 vdcw. Like the CY13C, the CY17C in a larger case size features thin design (5/64 in.) whose lead geometry permits axial, radial or edge mounting. Dissipation factor is less than 0.0005 with a Q over 2,500. Insulation resistance is greater than 50,000. **Circle 417 on Reader Service Card.**

Dry Batteries
expanded line

BURGESS BATTERY CO., Division of Servel, Inc., Freeport, Ill., announces an extensive line of dry batteries for virtually all modern transistor and tube type portable radios and battery-operated electronic circuits. Types available include carbon zinc cylindrical cells; rectangular-shaped cells; and wafer cells, consisting of a sandwich of artificial manganese dioxide mix between disks of flat zinc and carbon electrodes. **Circle 418 on Reader Service Card.**

Recorder
servo-operated

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1521-A graphic level recorder is a pen-type, servo-operated recorder completely transistorized. It plots the rms level of a-c voltages from 20 cps to 200 kc and can also be used as a linear d-c recorder. Paper speeds are 2.5 in. per hr to 75 in. per minute; writing speeds up to 400 db per sec. It plots frequency characteristics automatically. **Circle 419 on Reader Service Card.**

Transistors
computer type

INDUSTRO TRANSISTOR CORP., 35-10 36th Ave., Long Island City 6, N. Y. Two series of *pnp* germa-

CIRCLE 210 READERS SERVICE CARD→

New Product Announcement

STEMCO TYPE MX* THERMOSTATS

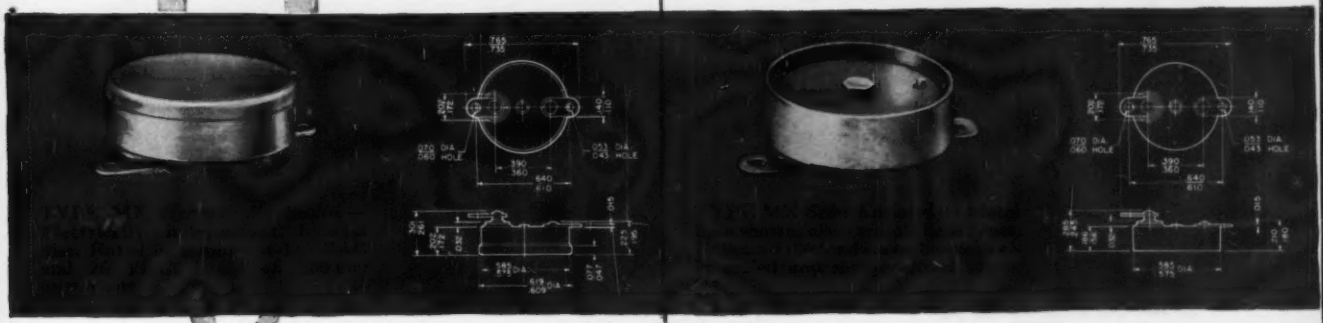
especially designed for missile, avionic and electronic applications

New Stemco Type MX Thermostats are miniature snap-acting units designed to *open* on a temperature rise. Being compact, lightweight units able to withstand high G's under wide ambient temperature ranges, Type MX thermostats are ideal for missile, avionic and other electronic applications where close temperature control is mandatory.

Basic design flexibility of the Stemco Type MX Series means the units can be supplied from regular production runs in a wide variety of models, both semi-enclosed or hermetically sealed. Ceramic or metal bases for semi-enclosed units, round enclosures or CR-7 crystal cans for hermetically sealed units. Several types of terminal arrangements, mounting provisions, brackets, etc., are available.

Stemco Type MX thermostats give you performance . . . small cubage . . . rugged reliability . . . *at a production price.*

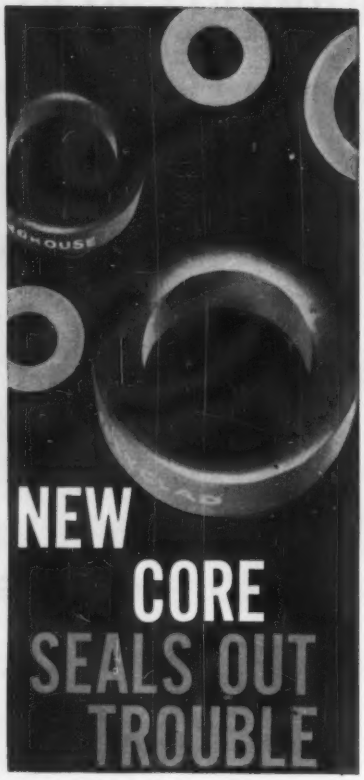
*** 2° to 6°F differentials available**



AA-7288

STEVENS *manufacturing company, inc.*
Mansfield, Ohio

STEMCO®
THERMOSTATS



The Westinghouse hermetically sealed, Polyclad Hipermag core is the newest development in cores for magnetic amplifier applications. Applied over a new specially designed aluminum box housing the core, Polyclad insulation hermetically seals the core and allows encapsulating, casting or impregnating without altering magnetic properties. This special core:

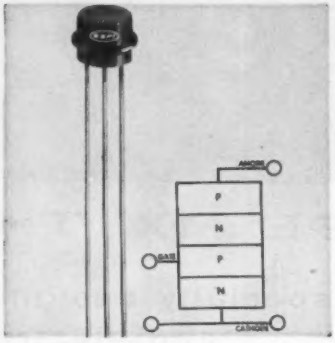
- Stops magnetic amplifier rejects caused by changed magnetic values.
- Is suitable for all environmental conditions — high temperatures, humidity and high-voltage stress.
- Eliminates costly core taping.
- Is tested by Roberts constant-current, flux reset technique, or to your specification.

Available in production lots with normal delivery, these cores are supplied in special sizes or in standard AIEE sizes.
For more information about these or other Hipermag or Hipersil® cores, call your Westinghouse representative . . . or write Westinghouse Electric Corporation, P.O. Box 231, Greenville, Pennsylvania. J-70855

YOU CAN BE SURE...IF IT'S
Westinghouse

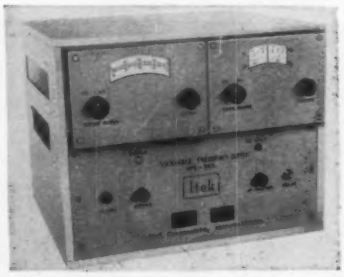
WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS
CIRCLE 211 READERS SERVICE CARD

nium transistors are now being supplied to specifications which meet or exceed all reliability requirements of MIL-T-19500 A. These series are the 2N425, 2N426, 2N427, 2N428, and the 2N315, 2N316, 2N317. They are designed and tested for use in medium and high speed switching and computer applications. **Circle 420 on Reader Service Card.**



PNPN Switch
high speed

SOLID STATE PRODUCTS, INC., Salem, Mass. With voltage ratings to 200 v, peak current ratings to 1 ampere and 0.2 μsec typical turn-on time, the silicon *pnpn* controlled switch makes possible high speed medium power switching in a wide variety of applications. Within their power ratings the 3A series of silicon *pnpn* switches can replace magnetic amplifiers, thyratrons, tubes, semiconductor diodes, rectifiers and transistors. **Circle 421 on Reader Service Card.**



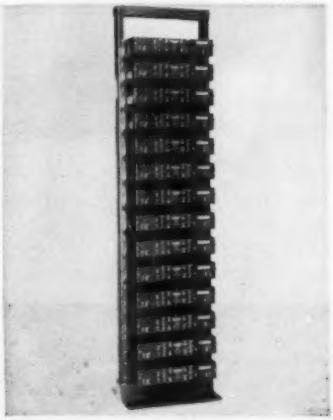
Power Supply
variable frequency

ITEK CORP., 1609 Trapelo Road, Waltham 54, Mass. The VFS 300 variable frequency power supply provides continuous output power of 250 va and may be used intermittently at 300 va. Output frequency is continuously variable from 45 to 2,000 cps with a variable output voltage of 0.140 v rms. Its many applications include testing airborne electronic systems, powering choppers and vibrators, and controlling processing equipment. **Circle 422 on Reader Service Card.**

Other Products

Voltmeter
electrostatic type

MONROE ELECTRONIC LABORATORIES, INC., Middleport, N. Y. Model 107A feedback electrostatic voltmeter permits the measurement of the free space electrostatic potential of a small area on an electrostatically charged surface by placing a probe in proximity to the surface. Range is ±1,000 v; bandwidth, d-c to 50 cps. Drift is generally less than 5 v per day after two-hour warmup. **Circle 423 on Reader Service Card.**



Multiplex Equipment
compact, flexible

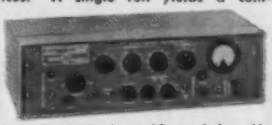
MOTOROLA INC., 4501 W. Augusta Blvd., Chicago 51, Ill., has introduced a new line of compact, highly flexible and reliable multiplexing equipment, called MC-20. Double side band frequency modulation is employed in the new gear. The 48 subcarrier channels and

SEE them in action

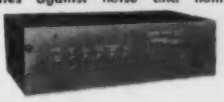
PANORAMIC'S SPECTRUM ANALYZERS

0.5 cps through 44,000 mc

The SF-2, Panoramic's Synchronous Frequency Analyzer is all electronic, instantaneously tracks speed changes in dynamic balance and resonance analyses of rotating and reciprocating devices. A single run yields a complete plot of frequency vs. amplitude. Used in conjunction with the LP-1a, it has a frequency range up to 7500 cps . . . tracks fundamental or 2nd, 3rd, 4th and 5th harmonic. Selectivity adjustable from 10 cps-1 kc. Lin and 40 db log calibrated amplitude.



The G-6, Panoramic's Broad Band Response Indicator, extends the range of Panoramic's Curve Tracing Systems to 15 mc! In combination with the SPA-3, it shows response to fundamental frequency only, gives a single line presentation, discriminates against noise and hum and has virtually unlimited dynamic range. 0-15 mc range in 0-3 mc segments. 1 v. into 72 ohms output with up to 60 db attenuation.



The LF-2a, Panoramic's Improved Subsonic Spectrum Analyzer, has a redesigned pen recorder, stablized baseline, a second (externally activated) pen for marker injection, an optional internal 3" CRT, a more precise center frequency control and all the features that made the LF-2 ideal for applications where exceptionally high resolution is required or where analyses are made over extended periods. Frequency range 0.5-2250 cps.

The new Function Selector Panel for the LP-1a, Panoramic's Sonic Spectrum Analyzer, permits critical analysis of random and other complex waveforms. To the LP-1a's standard features it adds 10-1000 cps adjustable IF bandwidth, 1-0.1 cps adjustable video (low pass) output filter, and a voltage calibration reset.

The SSB-3, Panoramic's New Rapid Test instrument for SSB Transmissions, combines in one convenient package a sensitive spectrum analyzer (the SB-12a Panalyzor), a stable tuning head, a two-tone generator and internal calibrating circuitry, to set up, adjust, monitor and trouble-shoot SSB and AM transmissions. Simple to operate, compact and exceptionally low-priced.

The SPA-2, Panoramic's New Microwave Spectrum Analyzer, was specifically designed for high resolution analysis of broad pulse spectra. Two tuning heads with a frequency range from 30-4000 mc, 200 cps resolution 1 mc sweep width continuously reducible to 0 with IF bandwidth, control, 40 db log, 20 db lin and square law amplitude scales, calibrated and continuously variable differential markers.

The SPA-4, Panoramic's Advanced High-Frequency High-Sensitivity Spectrum Analyzer, has a range of 10 mc to 44,000 mc with one tuning head, many unique features and tremendous flexibility. Resolution continuously variable from 1 kc to 80 kc. 70 mc wide sweep width continuously adjustable to 0. Careful shielding to avoid interference. Calibrated power, voltage and log amplitude scale.

SEE how they can solve your measurement and analysis problems

Panoramic's forward thinking, long and specialized experience in the development of spectrum analyzers, brings to you the human engineering and stable, direct reading displays that make possible rapid and reliable analysis for your measurement problems . . . whether it be subsonic or microwave . . . noise, vibration, instabilities of oscillators, detection of parasitics, studies of harmonic outputs or your own special problem.

Here are just a few of Panoramic's long line of widely accepted and completely dependable instruments. If you won't be at the Show, write NOW for technical bulletins, new CATALOG DIGEST and ask to be put on the regular mailing list for THE PANORAMIC ANALYZER featuring application data.

the pioneer is the leader

PANORAMIC

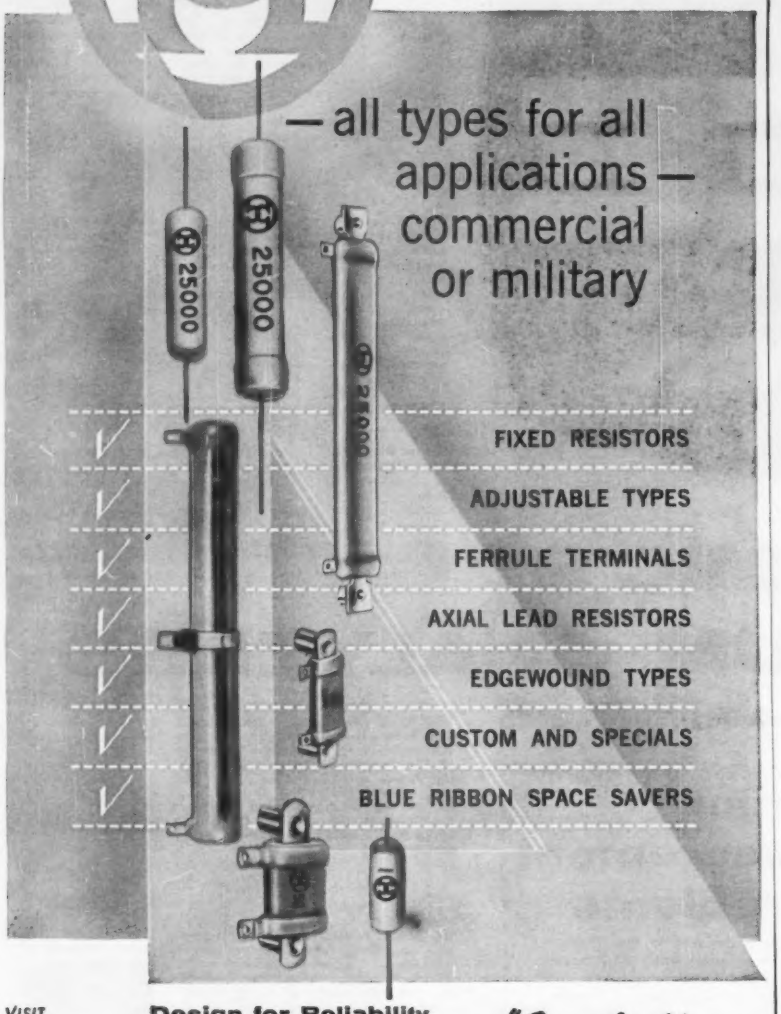
dependable **CERTIFIED SPECIFICATIONS** *for accurate data*

530 South Fulton Ave., Mount Vernon, N. Y.
Phone: OWens 9-4600 Cables: Panoramic, Mount Vernon, N. Y. State

at IRE booth 3515-3517

FROM HEADQUARTERS

H-H RESISTORS



VISIT BOOTH 3848 I.R.E. SHOW!

Design for Reliability with the Hardwick, Hindle *"Gray Line"

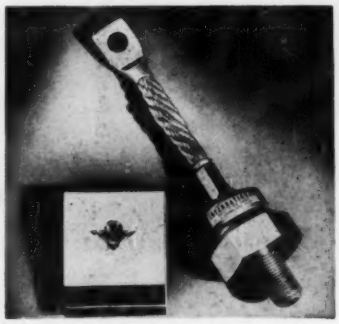
These high reliability components incorporate special design and construction features that assure the highest degree of dependability under the most adverse operating conditions. Non-crazing high temperature gray enamel, stronger core, welded wire connections, higher shock resistance, immunity to salt spray and humidity are advantages inherent in all H-H resistors. Fixed, ferrule and adjustable types comply with MIL-R-26 specifications and meet EIA standards.

***Where Space is a Factor —**
specify H-H Blue Ribbon Space Saver Resistors. Sold through authorized H-H distributors nationwide. Call or write for catalog including both Gray Line and Blue Ribbon Resistors, MIL Types, mounting brackets and accessories. Ask for your copy, now!

The Mark of Quality since 1924

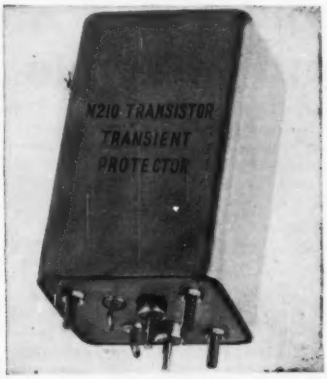
HARDWICK, HINDLE · INC
40 HERMON ST., NEWARK 5, NEW JERSEY

the service channel occupy a bandwidth extending from 200 kc to 1 mc. The basic multiplex channel terminal units occupy only 3½ in. rack space, enabling the mounting of up to 15 terminals in a standard 7 ft, 19 in. wide microwave equipment rack. **Circle 424 on Reader Service Card.**



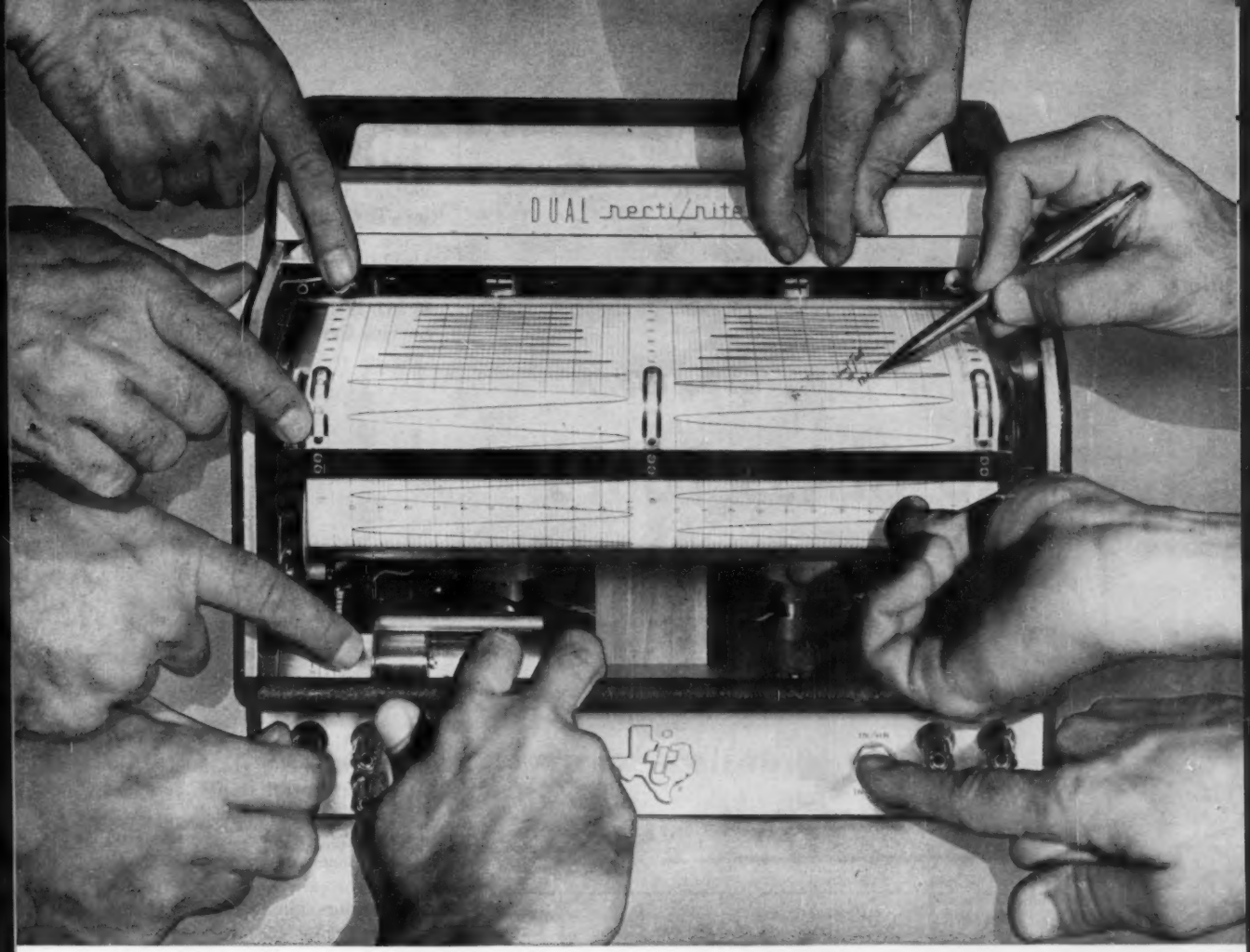
Silicon Rectifier
70 to 250 amperes

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. High current silicon power rectifiers providing d-c forward currents up to 250 amperes with a maximum piv range from 50 to 500 v are available. Units are designed for use at high temperatures and are capable of operation at a junction temperature of 190 C. **Circle 425 on Reader Service Card.**



Transient Protector
transistorized

ALTO SCIENTIFIC CO., 855 Commercial St., Palo Alto, Calif. Model N210 transistor transient protector reduces h-v transients appear-



recti/riter® recorders make YOUR work easier with up-front control of all operations

Work-saving "recti/riter" recorders place all routine adjustments and controls at your fingertips for maximum operator convenience.

With the greatest ease and speed, you can . . .

1. Raise the transparent, dust-proof door . . .
2. Make notes on "writing desk" area . . .
3. Remove, tear off, or change chart paper . . .
4. Flip the power switch . . .
5. Adjust zero position of writing pens . . .
6. Make connections to front terminals . . .
7. Select any of 10 chart speeds . . .
8. Advance chart paper as desired manually . . .
9. Check visible ink supply level or refill.

And, of course, removal of the dust cover makes every working part completely accessible — and removable — without further disassembly.

Add to these convenient features true rectilinearity, side-by-side time-correlated traces readable at a glance, fast rise time, galvanometer dependability and ±1% full-scale accuracy. Yes, and remember —*only* "recti/riter" systems (recorders and matching accessories) provide these wide ranges for recording electrical parameters:

10 millivolts to 1000 volts
500 microamperes to 1000 amperes
Monitor standard frequencies — 40, 60, 400 cps

Just a word from you will bring complete information on the "recti/riter" line. Inquire today!

TEXAS INSTRUMENTS
INCORPORATED
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OTHER TI/IID PRODUCTS

- Complete Geophysical Instrumentation
- DATA-GAGE Measurement and Control Systems
- Automatic Test Equipment

CIRCLE 214 READERS SERVICE CARD

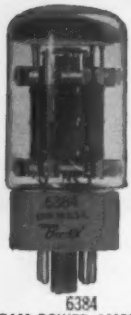
SPECIALLY BUILT TO WITHSTAND
SEVERE OPERATING CONDITIONS

Bendix Red Bank

HY-G-300

HARD GLASS TUBES

6094
BEAM POWER AMPLIFIER



6384
BEAM POWER AMPLIFIER

6754
FULL-WAVE RECTIFIER

- Ideal for modern high-performance aircraft and missiles.
- Processing at higher vacuum and under the higher heat permitted by the hard glass reduces gas and contamination and provides greater operating stability at higher temperatures.
- Ceramic element separators prevent emission loss from high heat and vibration.
- Solid aluminum oxide heater-cathode insulator eliminates shorts, reduces leakage.

For complete line of tubes, write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

ELECTRICAL RATINGS*	6094 Beam Power Amplifier	6384 Beam Power Amplifier	6754 Full Wave Rectifier
Heater Voltage (AC or DC)**	6.3 volts	6.3 volts	6.3 volts
Heater Current	0.6 amp.	1.2 amp.	1.0 amp.
Plate Voltage (Maximum DC)	300 volts	750 volts	350 volts
Screen Voltage (Maximum DC)	275 volts	325 volts	—
Peak Plate Voltage (Max. Instantaneous)	550 volts	750 volts	—
Plate Dissipation (Absolute Max.)	14.0 watts	30 watts	—
Screen Dissipation (Absolute Max.)	2.0 watts	3.5 watts	—
Heater-Cathode Voltage (Max.)	±450 volts	±450 volts	±500 volts
Grid Resistance (Maximum)	0.1 Megohm	.1 Megohm	—
Grid Voltage (Maximum)	5.0 volts	0 volts	—
(Minimum)	−200 volts	−200 volts	—
Cathode Warm-up Time	45 sec.	45 sec.	45 sec.

*For greatest life expectancy, avoid designs which apply all maximums simultaneously.

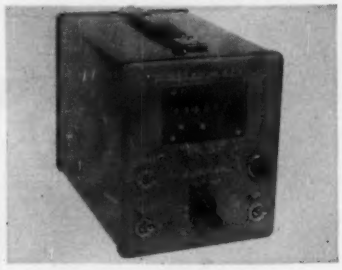
**Voltage should not fluctuate more than ±5%.

MECHANICAL DATA	6094	6384	6754
Base	Miniature 9-Pin	Octal	Miniature 9-Pin
Bulb	T-6½	T-11	T-6½
Maximum Over-all Length	2½"	3 15/32"	2¼"
Maximum Seated Height	2⅛"	2 1/16"	2⅛"
Maximum Diameter	⅞"	1 1/16"	⅞"
Mounting Position	Any	Any	Any
Maximum Altitude	80,000 ft.	80,000 ft.	80,000 ft.
Maximum Bulb Temperature	300°C	300°C	300°C
Maximum Impact Shock	500G	500G	500G
Maximum Vibrational Acceleration	50G	50G	50G

West Coast Sales and Service: 117 E. Providencia Ave., Burbank, Calif.
Canadian Affiliate: Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ont.
Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

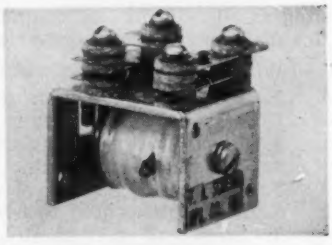
Red Bank Division — Bendix AVIATION CORPORATION

ing at a nominal 28-v power line. Load currents up to 30 amperes maximum may be passed with a voltage drop of input to output of 1 v. The clipping level of the input spike voltage (which may be an absolute maximum of 80 v) is 35 v. Size of the unit is 2½ in. by 2½ in. by 3½ in. **Circle 426 on Reader Service Card.**



Digital Totalizer transistorized

POTTER AERONAUTICAL CORP., Route No. 22, Union, N. J. Model 521 transistorized digital totalizer features extreme reliability, compact design and moderate cost. All circuitry is stabilized for operation at temperatures up to 160 F. Modular plug-in subassemblies are print-wired and assure simple maintenance. The high sensitivity (10 mv) of the 521 permits totalization of any "events" which can be converted to electrical impulses, that is, flow, revolutions, production-line units, and the like. **Circle 427 on Reader Service Card.**

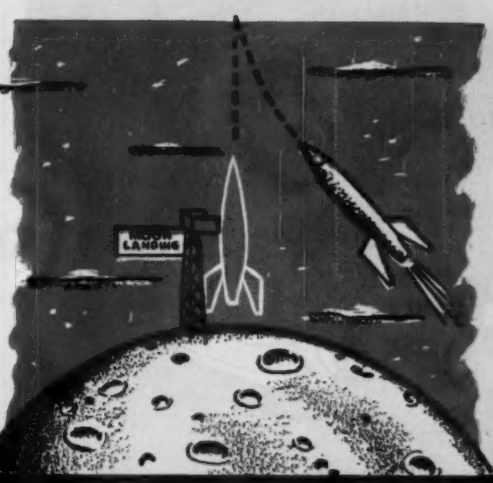


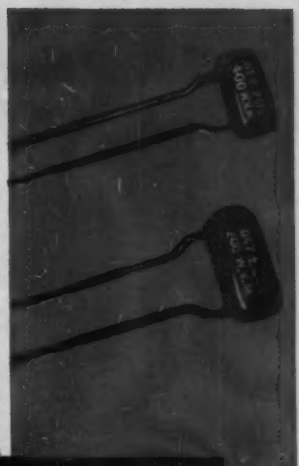
Compact Relay antenna-switching

F. A. SCHERMA MFG. CO., INC., 424 Broome St., New York 13, N. Y., announces a new compact and rugged antenna-switching relay. Unit is designed for mobile communications in the 180 mc range. It is available with palladium con-

It could happen... with

El-Menco CAPACITORS!





NEW *Mylar-Paper Dipped* CAPACITORS TYPE MPD

INSURE FAILURE-PROOF PERFORMANCE!

Only 1 Failure in 7,168,000 Unit-Hours for 0.1 MFD Capacitors

Setting a new standard of reliability!

*Life tests have proved that El-Menco Mylar-Paper Dipped Capacitors — tested at 100°C with rated voltage applied — have yielded a failure rate of only 1 per 716,800 unit-hours for 1 MFD. Since the number of unit-hours of these capacitors is inversely proportional to the capacitance, 0.1 MFD El-Menco Mylar-Paper Dipped Capacitors will yield ONLY 1 FAILURE IN 7,168,000 UNIT-HOURS.

SUPERIOR FEATURES!

● *Five case sizes in working voltages and ranges:*

200 WVDC —	.018 to .5 MFD
400 WVDC —	.0082 to .33 MFD
600 WVDC —	.0018 to .25 MFD
1000 WVDC —	.001 to .1 MMF
1600 WVDC —	.001 to .05 MFD

SPECIFICATIONS

● TOLERANCES: ±10% and ±20%. Closer tolerances available on request.

● INSULATION: Durez phenolic resin impregnated.

● LEADS: No. 20 B & S (.032") annealed copper-weld crimped leads for printed circuit application.

● DIELECTRIC STRENGTH: 2 or 2½ times rated voltage, depending upon working voltage.

● INSULATION RESISTANCE AT 25°C:
For .05MFD or less, 100,000 megohms minimum.
Greater than .05 MFD, 5000 megohm-microfarads.

● INSULATION RESISTANCE AT 100°C:
For .05MFD or less, 1400 megohms minimum.
Greater than .05MFD, 70 megohm-microfarads.

● POWER FACTOR AT 25°C:
1.0% maximum at 1 KC.

Write for Technical Brochure Giving Complete Information on the El-Menco Tubular Dur-Paper Line.

THESE CAPACITORS WILL EXCEED ALL THE ELECTRICAL REQUIREMENTS OF E.I.A. SPECIFICATION RS-164 AND MILITARY SPECIFICATIONS #MIL-C-91A AND MIL-C-25A.

FOR FAILURE-PROOF PERFORMANCE . . . COUNT ON EL-MENCO MYLAR-PAPER DIPPED CAPACITORS . . . FROM MISSILE GUIDANCE SYSTEMS TO DATA PROCESSING EQUIPMENT!

*Registered Trade Mark of DuPont Co.

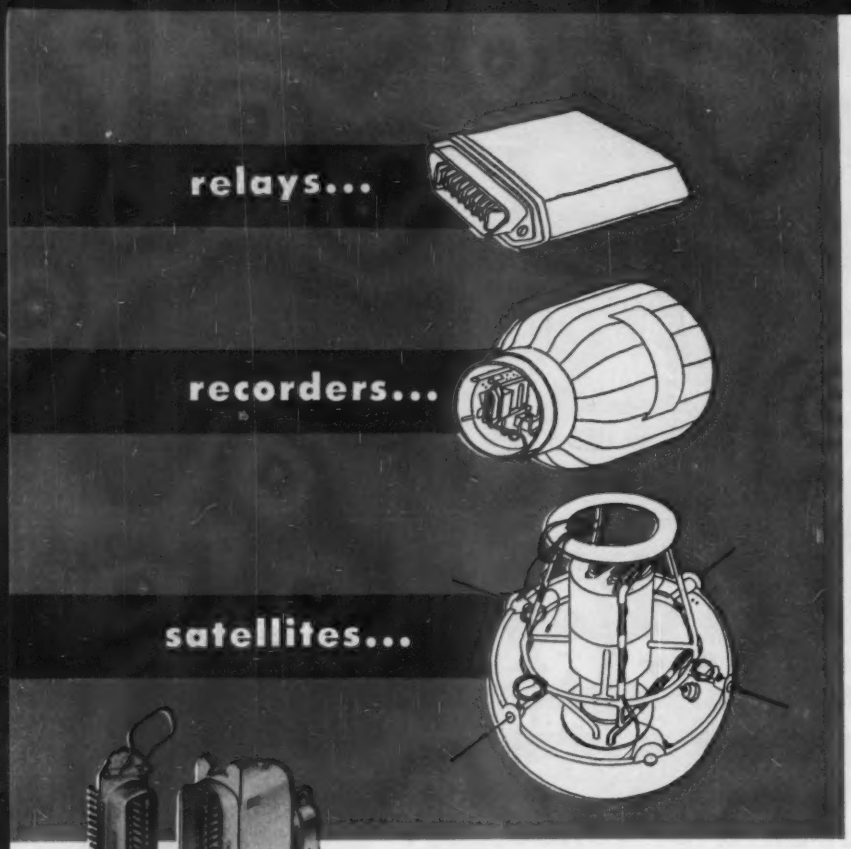
El-Menco Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.
WILLIMANTIC CONNECTICUT

Manufacturers of El-Menco Capacitors

● molded mica ● dipped mica ● mica trimmer ● dipped paper ● tubular paper ● ceramic ● silvered mica films ● ceramic discs

Arco Electronics, Inc., 64 White St., New York 13, N. Y.
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada



rely on Amphenol

Micro RIBBON CONNECTORS

Since their introduction a short time ago, AMPHENOL Micro-Ribbon connectors have been used in an ever-increasing number of high-reliability applications: Radioactivity recorders, relays, telephone equipment, computer modules, satellites—in hundreds of miniaturized applications where there can be no compromise with reliability.

Micro-Ribbons are the *first* miniature rack & panel connectors to provide increased reliability over their standard-size counterparts. With an improved "ribbon" contact (no tiny pin contacts to bend and misalign), Micro-Ribbons mate smoothly and efficiently, have easy insertion and extraction. Both mating members are self-wiping, self-cleaning members with double contact action at all times.

Contacts	Rack & Panel Plugs	Mating Receptacles	Cable-to-Chassis Plugs	Mating Receptacles
14	57-10140	57-20140	57-30140	57-40140
24	57-10240	57-20240	57-30240	57-40240
36	57-10360	57-20360	57-30360	57-40360
50	57-10500	57-20500	57-30500	57-40500

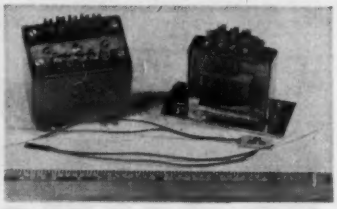
Investigate the features and specifications of AMPHENOL *Micro-Ribbon connectors—write for complete information.*

AMPHENOL *connector division*

AMPHENOL-BORG ELECTRONICS CORPORATION

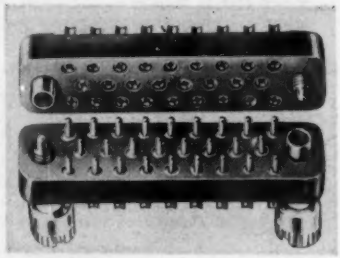
chicago 50, illinois

tacts (rated at 3 amperes) or silver contacts (rated at 5 amperes) and in arrangements of one or two pole normally opened or closed or double throw. Contacts are spaced so as to achieve low cross talk. The stack insulation and armature pusher is ceramic. Relay will withstand a minimum of 3 million operations. It will operate satisfactorily from −30 C to +85 C. **Circle 428 on Reader Service Card.**



Hall Generators high accuracy

DEVICE DEVELOPMENT CORP., 428 Boston Post Road, Weston, Mass. A complete line of Hall generators, which allow multiplication of two electrical quantities, feature better than one percent linearity over an output range of 100,000 to 1. These units, manufactured from indium arsenide and indium antimonide, have low temperature coefficients, high accuracy and repeatability, excellent h-f properties. **Circle 429 on Reader Service Card.**

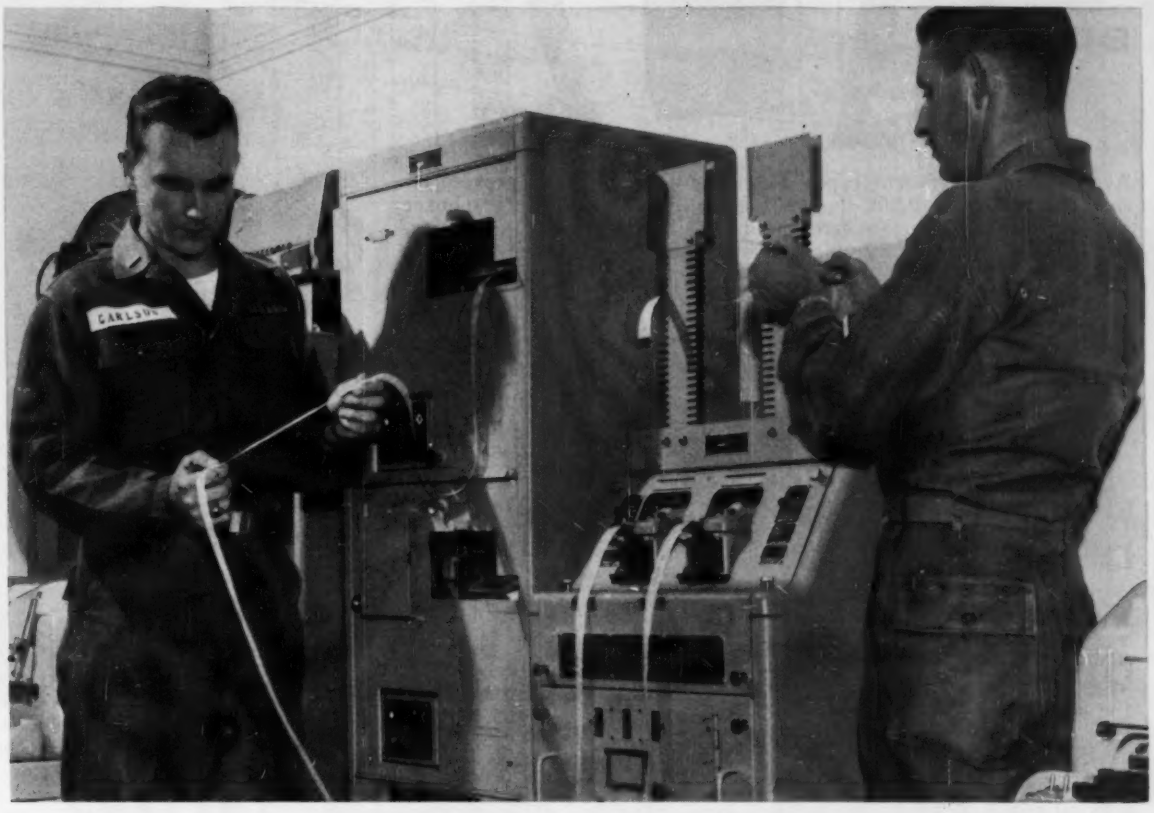


Connectors subminiature

U. S. COMPONENTS, INC., 454 E. 148th St., New York 55, N. Y., announces the SMI-C subminiature series precision connectors. A unique stainless steel reinforcing retainer is provided under each screwlocking element to remove all torque stresses from the molded bodies, avoiding breakage. Positive re-entrancy of

TOP LEVEL TALK

relayed on teleprinted tape



At U.S. Army field communications centers, Kleinschmidt torn tape relay units send, receive, retransmit messages to widely-dispersed commands

"Getting the word" from top command to outlying units in the field can create a communications traffic jam. This compact relay unit solves the problem. It quickly, accurately, automatically numbers and *prints* each message as it simultaneously *relays* another message to one or 100 receivers in the communications network! Developed in cooperation with the U. S. Army Signal Corps, the unit's applications include telemetering, integrated data processing, torn tape communication. In recognition of Kleinschmidt's high standards of performance, equipment produced for the U. S. Army is manufactured under the Reduced Inspection Quality Assurance Plan.

KLEINSCHMIDT

DIVISION OF SMITH-CORONA MARCHANT INC., DEERFIELD, ILLINOIS

Pioneer in teleprinted communications systems and equipment since 1911

DECADE BOXES

Available in 21 different types, Shallcross Decade Boxes provide resistances in 0.01 to 10,000 ohm steps up to 11,111,100 ohms. The boxes are made with precision wirewound resistors mounted on steatite-insulated switches . . . giving better than ± 0.1% accuracy above 10 ohms. Unmounted decades also available.

DECADE VOLTAGE DIVIDERS

Shallcross Decade Voltage Dividers are available in Kelvin-Varley or conventional potentiometer circuits. *Kelvin-Varley Circuit Models:* resolution to any ratio between 0.0000 and 1.0000 in steps of 0.0001 ohm; input resistances (accuracy ± 0.05%) from 10,000 to 100,000 ohms. *Potentiometer Circuit Models:* ohm steps from 0.1 to 10; total resistances from 1,000 to 100,000 ohms at ± 0.1% accuracy.

SECONDARY STANDARDS

Shallcross regularly supplies a variety of precisely-calibrated secondary resistance standards for critical research measurements. Overall stabilities better than 0.001% and maximum temperature coefficients of 3 ppm per degree C are achieved in several types.

Write for more complete technical information.

Shallcross

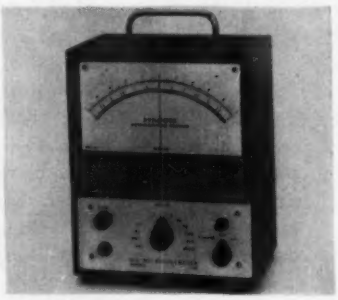
SHALLCROSS MANUFACTURING COMPANY, 2 Preston St., Selma, N.C.

"See Us At The IRE Show—Booth 2634"

the male pins is assured each time by a specially flanged guide female contact. Self-alignment action is also assisted by provision of wider countersink on upper end of contact. **Circle 430 on Reader Service Card.**

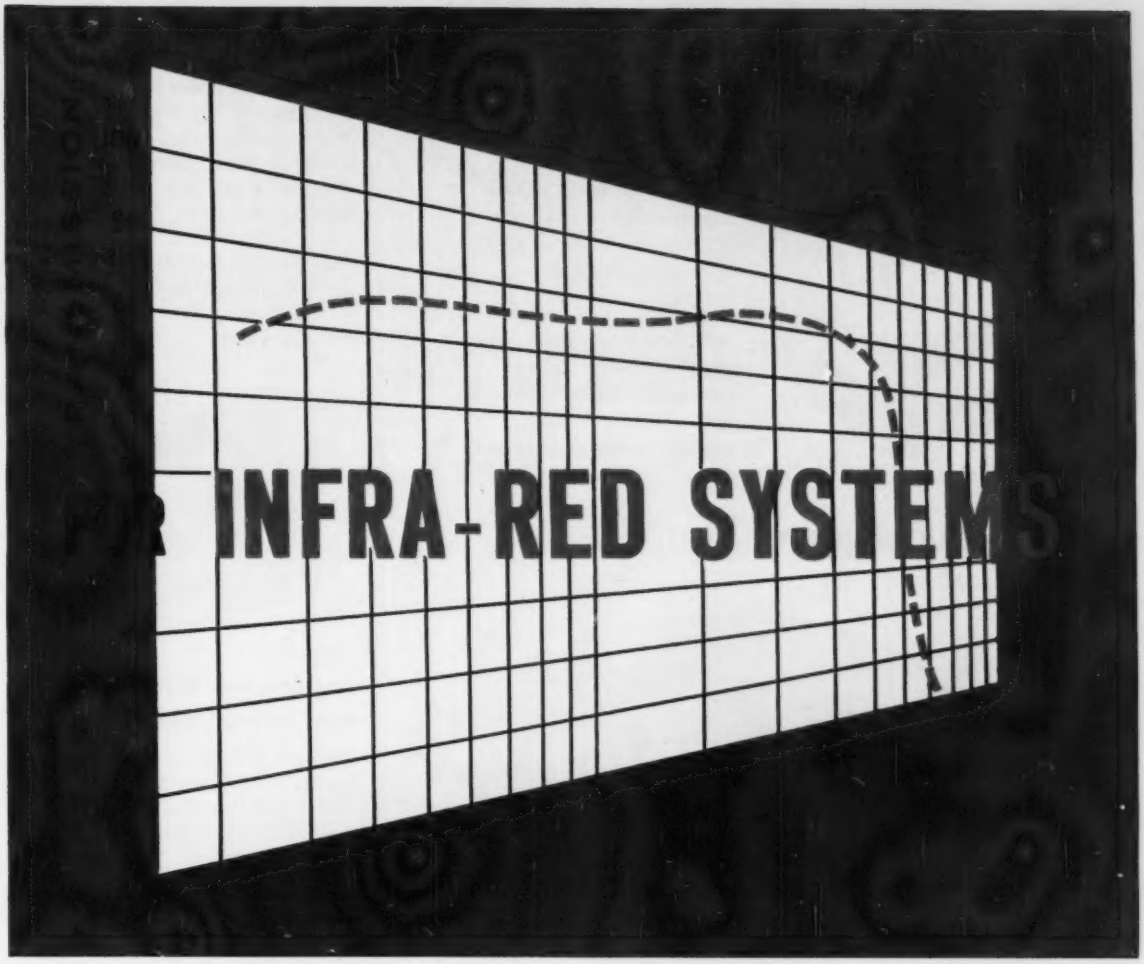
Accelerometer integrating type

DONNER SCIENTIFIC CO., Concord, Calif., announces a new transistorized integrating accelerometer. The new unit, a key component in several missile and aircraft programs, is used to both close a set of contacts at predetermined velocities and provide analog outputs relative to acceleration and velocity. These outputs are used in turn to actuate various control functions. Velocity contacts can be closed at any speed from a few fps to 50,000 fps up to accuracies of 0.25 percent over extended operational periods. **Circle 431 on Reader Service Card.**



D-C Microvoltmeter all-transistor

DYNAMICS INSTRUMENTATION CO., 1118 Mission St., South Pasadena, Calif. An all-transistor d-c microvoltmeter with over 100 megohms input impedance on all ranges from ±0.001 v to ±1,000 v, the



SPECIFY LINDE Sapphire

TRADE-MARK

LINDE Sapphire is...
Hard—Moh 9
Transparent, single crystal, pure aluminum oxide
Nonporous—0% porosity
Easily sealed to metals and ceramics
Priced competitively with sintered materials

LINDE Sapphire has...
Strength at elevated temperatures
High melting point—2040° C.
Excellent IR transmission at high temperatures (above 500° C.)

LINDE Sapphire is available as...
Windows
Domes
Rods and tubes
Special shapes—to order

For more information about LINDE Sapphire write "Crystals" Dept. BB-32.
LINDE COMPANY, Division of Union Carbide Corporation,
30 East 42nd Street, New York 17, N. Y.
In Canada: Linde Company, Division of Union Carbide Canada Limited.

Linde

UNION CARBIDE

LINDE synthetic sapphire is grown in a modified Verneuil furnace. This technique produces other single crystals including titania, spinel and special single crystals for the electronics industry.

"Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

CIRCLE 219 READERS SERVICE CARD

Sophisticated servo engineers with damping dithers are eliminating the cost and complication of lead-lag networks and notching filters by ingenious use of electromagnetic damping.

Beckman inertia damp and adjustable velocity damp servomotors give high frequency response ... help cut system clutter, size and weight ... reduce maintenance.

Servo systems simplified!

Wise designers are using 26-volt and 115-volt 400-cycle Beckman units, in sizes 8, 11, 15 and 18, in environments more hellish than imagined by MIL-E-5272A, where utmost reliability is paramount.*

Methodical engineers with sophisticated inclinations can get the inside story by writing for Data File A 33 ... a brief of inertia and velocity damp theory and practice.

*Names of companies now using these Beckman units are available on request.

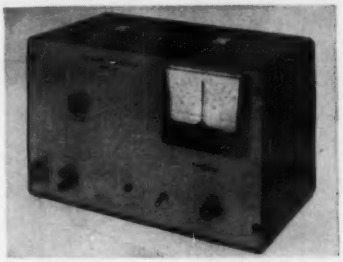
Beckman® / Helipot®

Helipot Division of
Beckman Instruments, Inc.
Fullerton, California
Engineering representatives
in 29 cities

1472

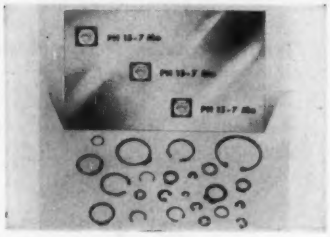
potentiometers : dials : delay lines : expanded scale meters : rotating components : breadboard parts

model 1362 features 12 hours continuous operation from an integral storage battery. Recharge is automatic when the instrument is plugged into the power line. Intended especially for low-level measurements in delicate transistor circuits, it is chopper-stabilized to avoid drift problems, and provides total isolation from the power line. **Circle 432 on Reader Service Card.**



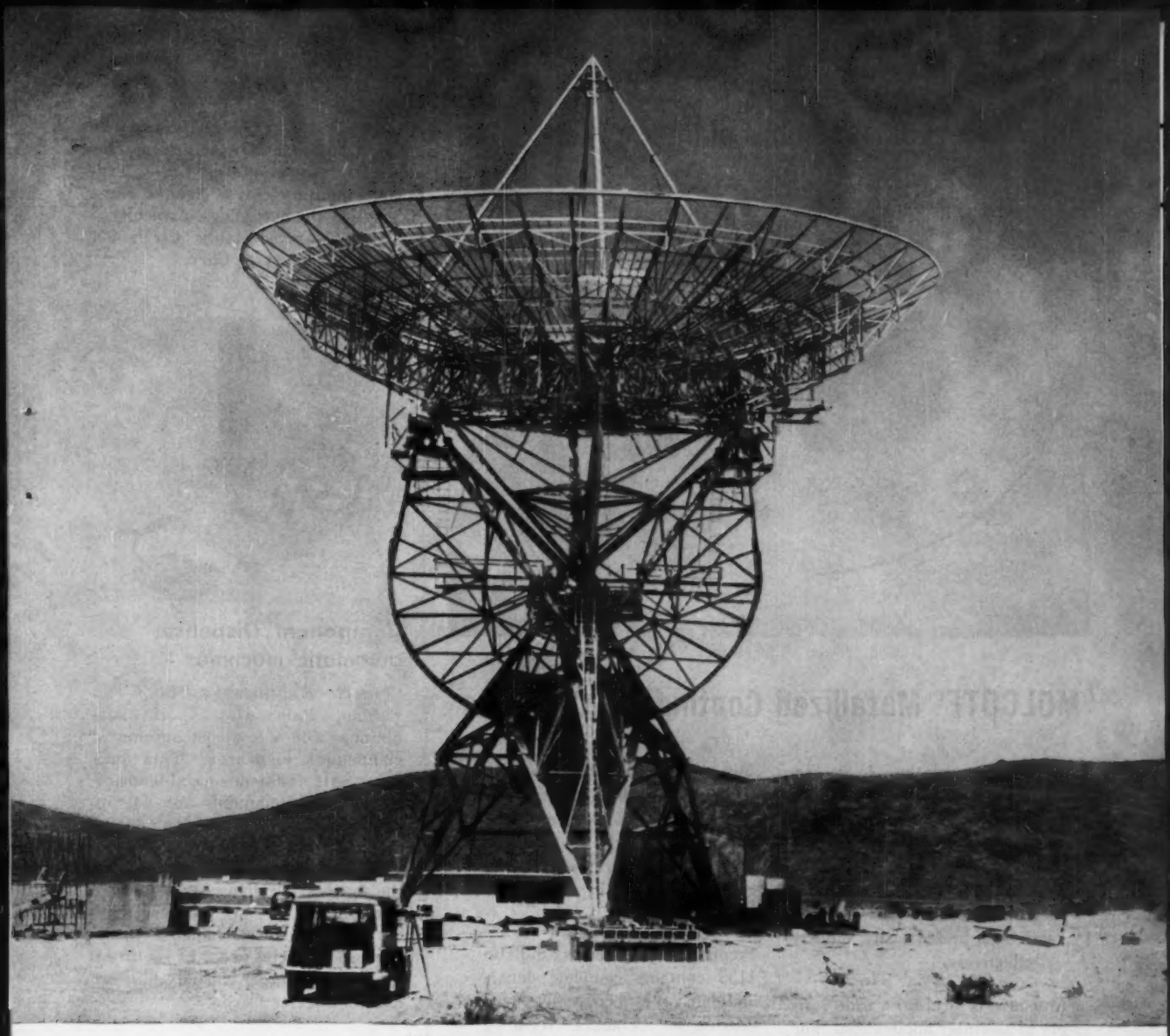
Impedance Comparator has varied uses

DYTRONICS, 78 Sunnyside Lane, Columbus 14, Ohio. Uses for the model 506 impedance comparator include fast and accurate tracking of potentiometers, temperature coefficient measurements and the matching and sorting of components. Resistors, capacitors or inductors may be directly compared without adjustment. Four sensitivity ranges make possible the measurement of impedance differences from a small fraction of 1 percent to 20 percent. **Circle 433 on Reader Service Card.**



Retaining Rings high-strength steel

WALDES KOHINOOR, INC., 47-16 Austel Place, Long Island City 1, N. Y. A new high-strength, precipitation hardening stainless steel alloy which provides unusual corrosion resistance at temperatures up to



85′ diameter tracking antenna, shown under construction. Reflector face surface is fabricated from aluminum. Pedestal, Polar Cage, Declination Cage and back up structure are of galvanized steel.

New BLAW-KNOX 85′ diameter tracking antenna for U.S. Lunar Probe Project

This newest Blaw-Knox 85′ Tracking Antenna is part of the Space Probe Project of the Jet Propulsion Laboratory at Pasadena, Calif. It will be used to maintain communications with space vehicles at ranges up to 250,000 miles.

Its design is fully determinate. All structural members of the assembly are analyzed for stress and deflection before fabrication. Coupled with shop fabrication and field erection to rigidly accurate tolerances, it is capable of the highest gain, with a minimum of distortions or aberrations.

The entire drive system embodies such critical design requirements as infinitely variable movement with negligible creep or overrun for tracking. The slewing drives are capable of the extremely rapid acceleration and deceleration necessary to focus on targets.

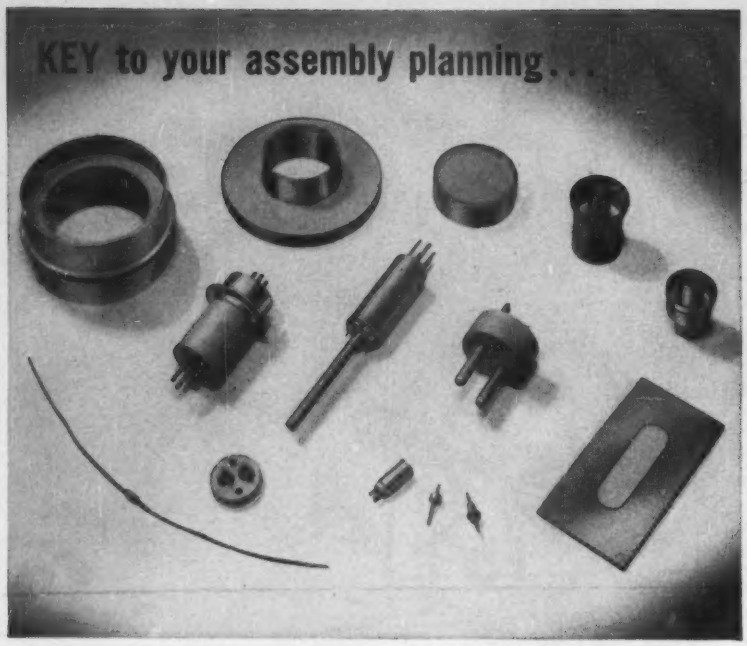
Pioneering like this is the latest step in a long series of Blaw-Knox developments. Such milestones as the Guyed Vertical Radiator design in AM radio, the first radar antenna used to bounce signals off the moon, and the Tropospheric Scatter Antenna for over-the-horizon television have marked Blaw-Knox as a world leader in advanced design, fabrication and erection techniques.

Blaw-Knox welcomes the opportunity to translate your most advanced concepts into highly reliable operating equipment. Contact the Antenna Group.

Antennas—Rotating, Radio Telescopes, Radar, Tropospheric and Ionospheric Scatter.

BLAW-KNOX

BLAW-KNOX COMPANY
Blaw-Knox Equipment Division
Pittsburgh 30, Pennsylvania



MOLCOTE® Metallized Coating for Ceramics

Now is a good time to get acquainted with MOLCOTE in your assembly planning. A metallized coating firmly bonded to ceramic, MOLCOTE presents a surface to which a metal part or other metallized ceramic parts may be soldered or brazed easily, quickly . . . effectively.

MOLCOTE is ideal for a wide variety of assembly applications. For example, it

. . . can be used effectively with copper brazing.

. . . can be immersed in a wide variety of molten brazing alloys for extended periods of time.

. . . permits excellent dimensional control.

. . . offers high bond strength.

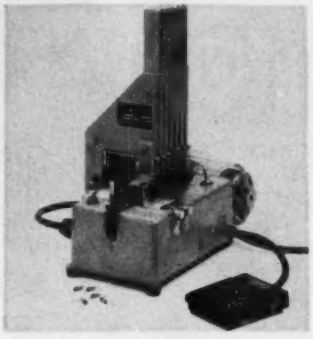
MOLCOTE surfaces are supplied ready for use for soldering and brazing applications in any temperature range up to 2000° F. MOLCOTE bonds are exceptionally strong with a tensile strength exceeding 10,000 psi.

Frenchtown Engineering Bulletin 1155 contains complete details and data on MOLCOTE Metallized Coating for Ceramics. We'd be pleased to send you a copy for use in your assembly planning. A good time to write for it is *NOW*.

frenchtown PORCELAIN COMPANY
FRENCHTOWN, NEW JERSEY

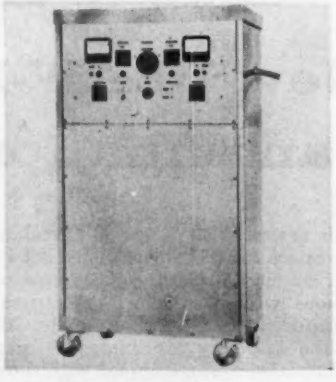
CIRCLE 222 READERS SERVICE CARD

1,000 F is now being offered as an additional metal specification for the company's complete line of Truarc retaining rings. Sample rings made of the new alloy—Armco type PH15-7—are available. **Circle 434 on Reader Service Card.**



Component Dispenser automatic machine

SCHMIT ENGINEERING CO., 862 Fabian, Palo Alto, Calif., announces a new low cost automatic component dispenser. This machine cuts and bends axial leads of electronic components for use in printed circuit or terminal board assembly operations. When used at a production station, a touch of the foot switch dispenses a formed component. The six hoppers may be programmed to dispense these parts in a precise order as required by the operator. **Circle 435 on Reader Service Card.**



D-C Power Supply 5 ma at 120 kv

DEL ELECTRONICS CORP., 521 Homestead Ave., Mt. Vernon, N. Y., has a

HIGH VOLTAGE SILICON RECTIFIERS

	Peak Inverse Voltage	Maximum Average Rectified Current(ma) 50° C	150° C	Maximum Surge Current Amps	Forward Voltage at Specified Current at 25° C	Inverse Current at Rated Voltage 25° C(μa)	125° C(μa)
1N560	800	500	250	5	1.3v at 250ma	10	300
1N561	1000	500	250	5	1.3v at 250ma	10	300
1N588	1500	25	10		10v at 10ma	5	100
1N589	1500	50	25		5v at 50ma	5	100

NORTH AMERICAN ELECTRONICS, INC.

212 Broad Street, Lynn, Massachusetts

... Measures absolute amplitude and relative delay characteristics of 600 ohm transmission circuits from 200 cycles to 24 kc. Temperature range 32°F to 130°F with 60 cycle line voltages from 105 to 125 volts. Overall precision and accuracy ±50 microseconds. Drift rate not exceeding ±50 microseconds per 30 minutes.

SPECIFICATIONS OF THE 451-A TRANSMITTER

CARRIER SWEEP RATE: Carrier frequency controlled manually or by a motor driven sweep capacitor at two sweep rates:
a. 1 cycle per 10 seconds, or 6 rpm.
b. 1 cycle per 100 seconds, or .6 rpm.

CARRIER FREQUENCY: Continuously adjustable from 200 cycles to 12 kc. The sweep width and position is adjustable within the 200 cycle-12 kc. limits. The minimum sweep width is 1500 cycles. An external oscillator can be used up to 24 kc.

REFERENCE FREQUENCY: Means are provided for switching the carrier frequency (normally controlled by the sweep capacitor) to a reference frequency anywhere in the 200 cycle to 12 kc. band.

MODULATION FREQUENCY: 25 cycles, derived through counting circuits from tuning fork control oscillator. 2 kc. tuning fork stability ±3 ppm at room temperature.

FREQUENCY METER: Carrier frequency continuously indicated on a direct-reading meter with an error not exceeding ±2.5% of full scale. Frequency meter calibration can be checked by inserting a 2 kc. signal from the local fork oscillator circuit.

TRANSMITTER OUTPUT SIGNAL: Output level adjustable in 5 db steps from −20 dbm to +10 dbm. These figures represent the peak power in the 50% modulated output signal applied to the output terminals. Maintains internal impedance of 600 ohms ±10 ohms from 200 cycles to 24 kc. The frequency characteristic of the output terminals is flat to within ±.25 dbm from 200 cycles to 24 kc.

TRANSMITTER SYNC. OUTPUT: 2 kc. signal can be used as a common time base in both the transmitter and receiver.

SPECIFICATIONS OF THE 452-A RECEIVER

INPUT IMPEDANCE: Internal impedance is 600 ohms ±10 ohms from 200 cycles to 24 kc.

INPUT LEVEL: The receiver will perform satisfactorily over the range from +10 dbm to at least −30 dbm by use of the manual attenuator control and operate over any 20 dbm range within the specified limits without change in the attenuator control. The input-level is indicated algebraically by an input attenuator calibrated in dbm and level meter calibrated in dbm. The meter range is 20 dbm; the attenuator range is 25 dbm in 2.5 db steps. All readings are peak input power to the receiver.

DELAY MEASUREMENTS: Delay is indicated on a relative basis, reference being to a cardinal point in the frequency band between 200 cycles and 24 kc. Measurements are obtained from a direct-reading meter which has two sensitivities: 2 ms and 20 ms full scale. The 0 to 2 ms range may be positioned anywhere in the 0 to 20 ms scale by means of a coarse control which adds or subtracts precise 500 microsecond increments of delay in the reference channel. A fine control is provided to obtain cardinal point adjustment.

FREQUENCY METER: Same as Transmitter.

AMPLITUDE TO PHASE CONVERSION: With a 20 db change in amplitude, the output delay indication will not change by more than ±50 microseconds.

TYPE 328-A TRANSISTORIZED PHASE METER

• Compact • Long-Time Stability • Phase Accuracy 1° From 10 Cps To 10 Kc • Frequency Range 10 Cps To 50 Kc • Direct Reading From 0° to 360° In 6 Ranges Of 60° Each On 5" Meter Scale.

Measures the phase angle in degrees between two sinusoidal or nonsinusoidal voltages. Amplitude range .25 to 170 volts peak except at low frequencies. Connector provided for recorder. Terminals provided for operation with external 45 volt battery. Power supply 105-125 volts 60 cycle A.C.

TYPE 7000-B AUDIO PRIMARY PHASE STANDARD

• Based on Frequency Division and Expanded Lissajous Presentation Extreme Accuracy.

Generates two sine waves having variable phase relation 0° to 360° which can be set to within ±0.01°, at any specified single frequency 60 cps to 20 kc. Angles which are multiples of 1° can be set to ±0.01°. Used for accurate phase calibration or measurement.

ACTON LABORATORIES, INC., ACTON 7, MASSACHUSETTS

A Subsidiary of Technology Instrument Corporation, Acton, Mass.

COlonial 3-7756 — Boston Line LIberty 2-2681

See us at our Booths Nos. 1916-1918 at the I.R.E. Show.

new d-c power supply, rated 5 ma at 120 kv, for industrial and experimental applications. Model 120-5-1 is designed to operate on a standard 115 v 60 cps line. Rectification is accomplished through the use of high quality selenium rectifiers. Reversible polarity is easily achieved by changing simple plug-in internal connections. Its ripple is less than 2 percent rms. The high voltage output is delivered through a shielded polyethylene cable. Unit is housed in a cabinet measuring 33½ by 21½ by 61 in. high. **Circle 436 on Reader Service Card .**

Capacitors electrolytic type

AEROVOX CORP., New Bedford, Mass. Type QE electrolytic capacitors are designed specifically for such critical applications as computer equipment, power supply filters, telephone networks, industrial electronic equipment and precision laboratory and commercial test equipment. They have a useful life expectancy of greater than ten years when operated within ratings. Units are rated for operation at temperatures from −20 C to +85 C. **Circle 437 on Reader Service Card.**

Silicon Diodes fast switching

CLEVITE TRANSISTOR PRODUCTS, 241 Crescent St., Waltham 54, Mass., offers a comprehensive line of small area silicon junction diodes for applications in which high temperatures, high dissipation, and high values of acceleration are encountered. Particularly suitable for high

3 ways to save money

with Cleco's 3-in-1 drill-screwdriver-nut runner

With the Cleco 10 Series Drill-Screwdriver-Nut Runner you save money because:

1. *You can reduce tool inventory.* The remarkable interchangeability features of these tools permit gear trains, motors, handles, and chucks to be interchanged. With a limited number of extra parts this tool can be made up with gear reductions for various speeds as a screwdriver-nut runner or drill.
2. *Cleco 10 Series cost less to operate.* They are equipped with *all new air motors.* Motors that are more powerful, yet actually require less air per h.p. output.
3. *They operate longer with less wear.* Cleco's new, non-friction, roller-type clutch "slips" when preset torque is reached; eliminates slugging; has unequaled torque holding ability. Friction-free clutch permits longer, *much longer,* periods of maintenance-free operation.

Call ***your Cleco representative for a demonstration tryout. See for yourself how economical, easy-to-handle, well-balanced, long-life Cleco 10 Series Drill-Screwdrivers-Nut Runners really are.***

CLECO
AIR TOOLS

DIVISION OF REED ROLLER BIT COMPANY
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IN CANADA: Cleco Pneumatic Tool Company of Canada, Ltd., 927 Millwood Road, Leaside (Toronto), Ontario

Thermal stability

Low noise

reliability

BRISTOL'S

low-noise, low-thermal Syncroverter* choppers

In solving the above equation, Bristol has paved the way for new advances in low level switching. New performance standards are being established by these latest models of the external coil Syncroverter chopper.

For complete specifications, write:
Aircraft Components Division, The Bristol Co.,
152 Bristol Road, Waterbury 20, Conn.

*T. M. Reg. U. S. Pat. Off.

D-1

BRISTOL FINE PRECISION INSTRUMENTS FOR SEVENTY YEARS

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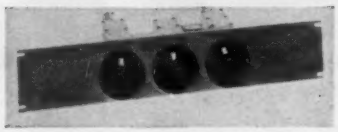
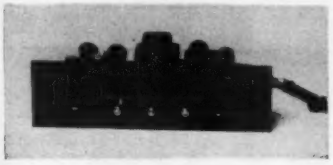
speed switching use under severe environmental conditions, these diodes consist of a rugged internal structure enclosed in a subminiature glass, hermetically sealed package. **Circle 438 on Reader Service Card.**



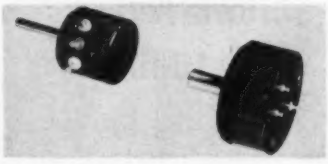
R-F Attenuator rotary adjustable

ORTHO FILTER CORP., 196 Albion Ave., Paterson 2, N. J., announces a new 50 ohm, r-f attenuator that is an extremely accurate variable step attenuator designed to operate from d-c to 500 mc. Units of this type are rotary adjustable and can be supplied as individual unmounted units or in various combinations on rack mounted panels. **Circle 439 on Reader Service Card.**



Power Supply modular unit

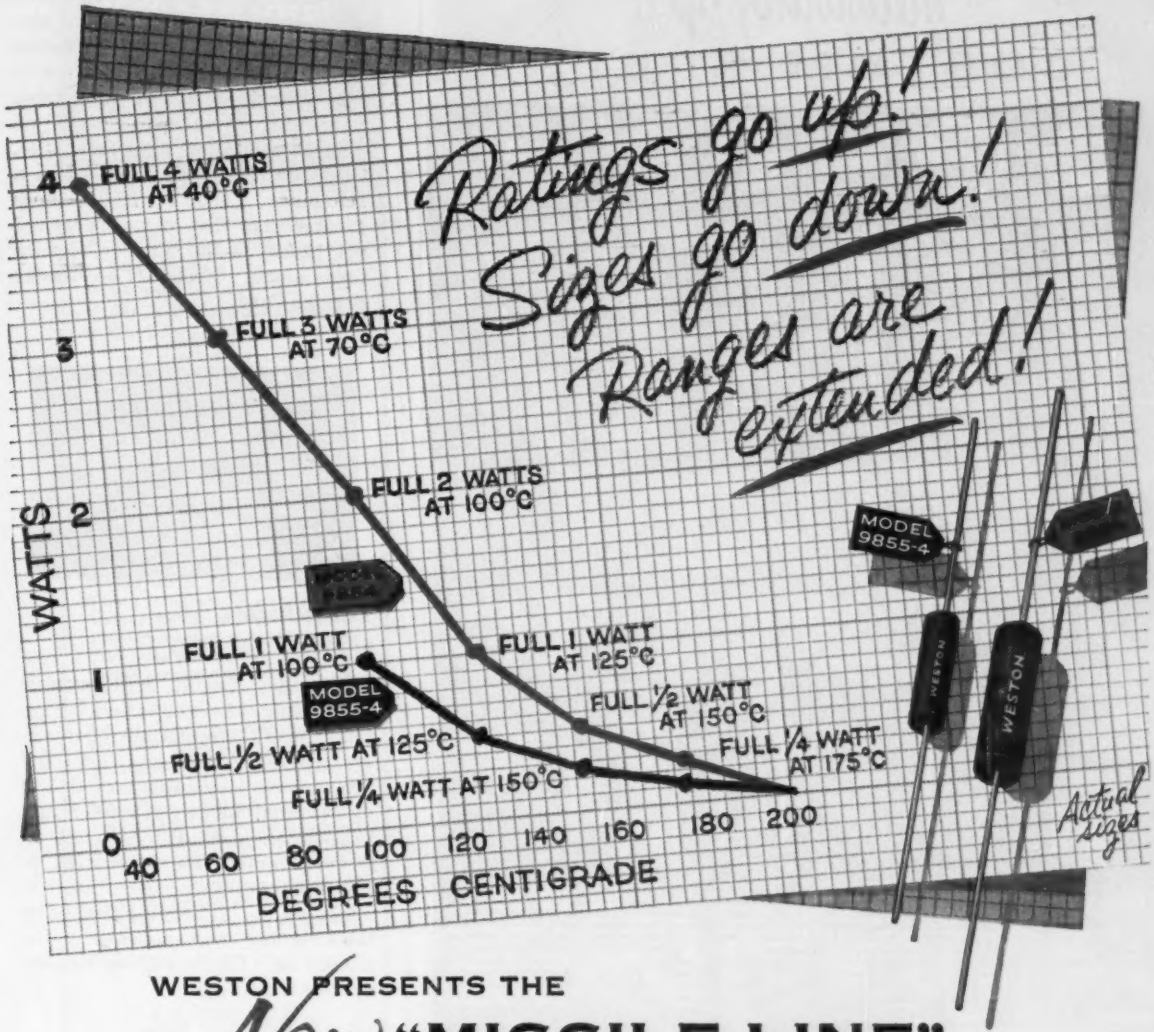
STERLING PRECISION CORP., 17 Matinecock Ave., Port Washington, N. Y. Model T869 gyro spin motor supply is a panel-mounted, self-contained modular unit for supplying either 2 or 3 phase power to spin motor. The unique design maintains motor at synchronous speed regardless of phase unbalance. **Circle 440 on Reader Service Card.**



Potentiometer conductive plastic

NEW ENGLAND INSTRUMENT CO., 320 Main St., Woonsocket, R. I. A

WESTON RESISTORS: STANDARDS OF STABILITY IN SCIENCE AND INDUSTRY



WESTON PRESENTS THE

New "MISSILE-LINE"

The new "Missile-Line" of Weston Vamistor® type metal film resistors is truly a major step in miniaturization. An *inert gas*–sealed within the hollow body of the resistors–permits rating increases that make *all* existing resistor specs obsolete. Because of the exceptional performance of these resistors at high ambient temperatures, the series has been named the "Missile-Line."

For example: a resistor the size of the former ½-watt-at-125°C unit can now dissipate *1 full watt* at 125°C–with less than 0.5% change in 1000 hour load life test. This RN-70 size resistor will outperform *any* existing RN-75 size. Likewise, the RN-65 size unit will outperform *any* existing RN-70 size.

Resistance ranges have also been extended. The range of Model 9854 (red curve above): 100 ohms through 2 megohms. Model 9855-4 (black): 100 ohms through 500 K.

For further information about these revolutionary Vamistors, contact your local Weston representative . . . or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10. Ont. Export: Daystrom Int'l. 100 Empire St., Newark 12, N. J.*

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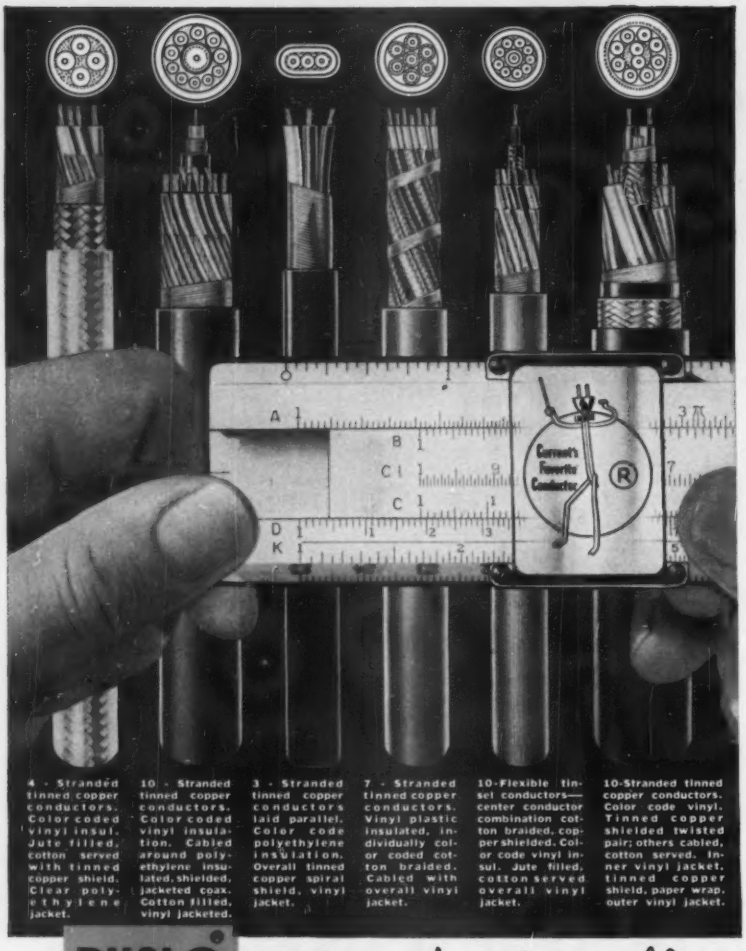

4 - Stranded tinned copper conductors. Color coded vinyl insul. Jute filled, cotton served with tinned copper shield. Clear polyethylene jacket.

10 - Stranded tinned copper conductors. Color coded vinyl insulation. Cabled around polyethylene insulated, shielded, jacketed coax. Cotton filled, vinyl jacketed.

3 - Stranded tinned copper conductors laid parallel. Color code polyethylene insulation. Overall tinned copper spiral shield, vinyl jacket.

7 - Stranded tinned copper conductors. Vinyl plastic insulated, individually color coded cotton braided. Cabled with overall vinyl jacket.

10-Flexible tinsel conductors—center conductor combination cotton braided, copper shielded. Color code vinyl insul. Jute filled, cotton served overall vinyl jacket.

10-Stranded tinned copper conductors. Color code vinyl. Tinned copper shielded twisted pair; others cabled, cotton served. Inner vinyl jacket, tinned copper shield, paper wrap, outer vinyl jacket.

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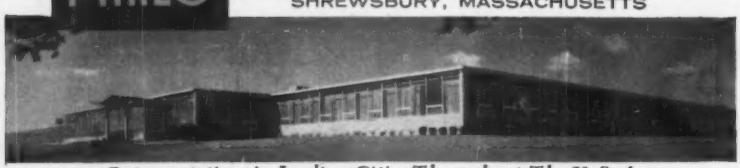

Representatives in Leading Cities Throughout The U. S. A.

new conductive plastic potentiometer, rotating at 2,000 rpm in a continuing test has gone to one hundred million revolutions with no measurable change in linearity or noise, near infinite resolution, and only 5 percent change in total resistance. Company claims for the product a reliability 1,000 to 3,000 times greater than that of a wire wound pot based on the number of wire turns alone. **Circle 441 on Reader Service Card.**

Transducers withstand 2,000 F

AUTOMATIC TIMING & CONTROLS, INC., King of Prussia, Pa. High temperature differential transformers, types 6208 HHK and 6206 HHK are now available. They are able to operate continuously at 1,000 F and to withstand 2,000 F for periods up to five minutes. The 6208 HHK is for linear displacement measurements up to ±0.150 in.; type 6206 HHK is for displacements up to ±0.500 in. **Circle 442 on Reader Service Card.**

Trimmer Pot half-in. diameter

TUCSON INSTRUMENT CORP., 1050 E. Valencia Road, Tucson 2, Ariz. Advanced design of the model H-0505-T trimmer pot enables it to operate at 150 C. With an ambient of 125 C this trimmer is able to carry 4 ma of current through its brush contact on the winding. Windings are available in resistances up to 100 K, with

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. . . the only oscilloscope capable of measuring the performance of high-speed semiconductors.

The Milli-Mike Oscilloscope reproduces pulse rise time on the order of a tenth of a millimicrosecond at relatively low signal voltages without the use of amplifiers. Frequencies as high as 3,000 megacycles and voltage levels of 40 to 50 millivolts can be detected and recorded.

PERFORMANCE DATA

	Vertical (TW)	Horizontal
Sensibility	.054 v/trace width	0.30 v/trace width
Nominal Spot Size (trace width)	0.002 inch	
Deflection	27 v/inch (nominal)	150 v/inch
Frequency Response	DC to greater than 3,000 mc (—3db at approx. 2,000 mc)	
Input Impedance	50 or 100 ohms	
Writing Speed	3 x 10" trace widths/sec.	

Let EG&G's experience in sub-millimicrosecond measurements assist you in the development, inspection and quality control of high-speed semiconductors.

The EG&G Milli-Mike Oscilloscope—one of a family of millimicrosecond instruments—is now being used to solve problems in measurement of recovery time of diodes, decay times of scintillators, discontinuities in transmission lines and as a synchroscope in high resolution radar systems.

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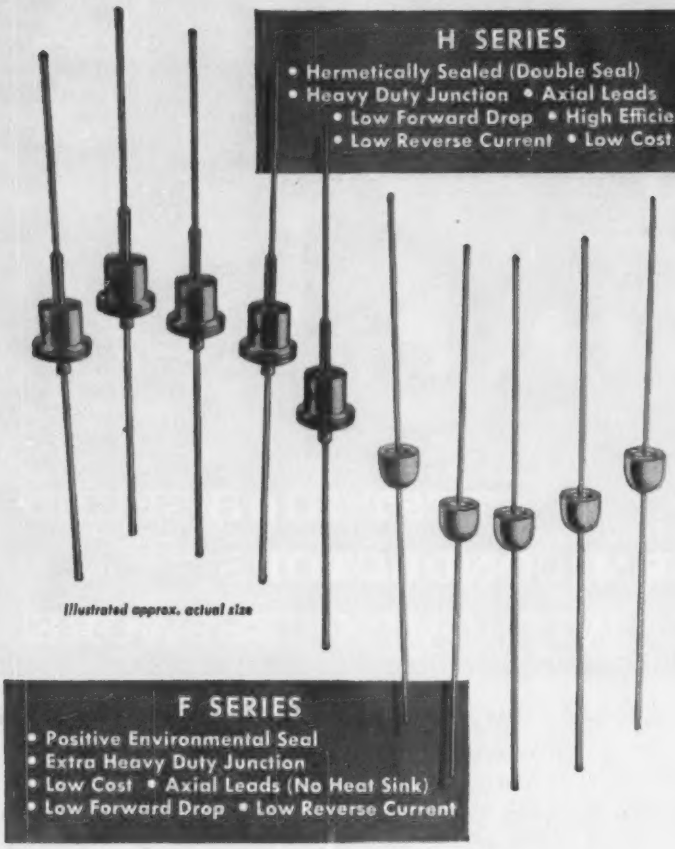
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F SERIES—ELECTRICAL RATINGS—Capacitive Loads

S. T. Type.	Max. Peak Inverse Volts	Max. RMS Volts	Current Ratings—Amperes											
			Max. D. C. Load			Max. RMS			Max. Recurrent Peak			Surge – 4MS Max.		
			55°C	100°C	150°C	55°C	100°C	150°C	55°C	100°C	150°C	55°C	100°C	150°C
F-2	200	70	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
F-4	400	140	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
F-6	600	210	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35

H SERIES—ELECTRICAL RATINGS—Capacitive Loads

S. T. Type	Max. Peak Inverse Volts	Max. RMS Volts	Current Ratings—Amperes											
			Max. D. C. Load			Max. RMS			Max. Recurrent Peak			Surge – 4MS Max.		
			55°C	100°C	150°C	55°C	100°C	150°C	55°C	100°C	150°C	55°C	100°C	150°C
10H	100	35	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
20H	200	70	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
30H	300	105	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
40H	400	140	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
50H	500	175	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
60H	600	210	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35

Write for design notes No. 30 and 31

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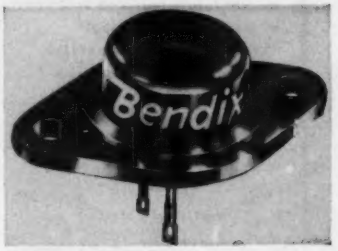
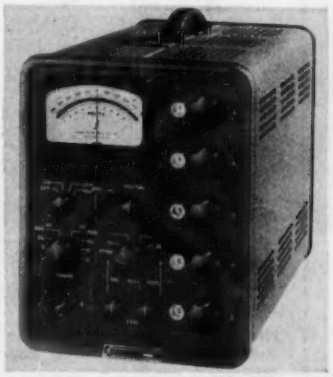
the higher resistance windings displaying the same ruggedness under environmental conditions as the lower values of resistance. Unit is designed to withstand 30 g's of vibration from 50-2,000 cps and 150 g's of shock with an 11 millisec duration, and to pass the humidity requirements of MIL-STD-202, method 106. **Circle 443 on Reader Service Card.**



Power Transistor diffused-alloy

BENDIX AVIATION CORP., Red Bank Div., Long Branch, N. J. A new diffused-alloy-power transistor series will meet the following performance standards: collector voltage ratings up to 120 v for h-v applications; very low input resistance for greater high temperature circuit stability; collector currents up to 10 amperes with extremely low saturation resistance; switching times less than 1 μsec in high speed circuits. **Circle 444 on Reader Service Card.**



D-C & A-C Voltmeter differential type

JOHN FLUKE MFG. CO., INC., 1111 W. Nickerson St., Seattle 99, Wash., announces model 803 precision d-c

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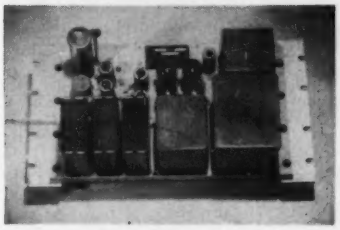
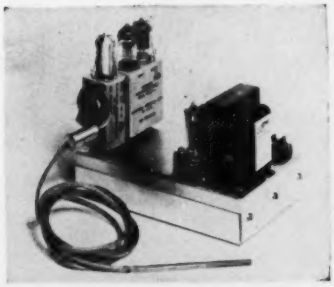
and a-c differential voltmeter. It features high order of accuracy for both d-c and a-c precision measurements; specifically, better than 0.05 percent d-c and 0.2 percent a-c accuracy from 0.1 v to 500 v. Frequency response of the a-c converter section is from 30 cps to 5 kc. **Circle 445 on Reader Service Card.**



Power Supply
MIL spec components

AMERICAN TIME PRODUCTS, INC., 580 Fifth Ave., New York 36, N. Y., announces type 2111F precision frequency power supply. Input is 115 v ± 15 percent, 50 to 500 cps. Output is one fixed frequency in the range 60 to 500 cps at an accuracy of ± 20 parts per million from 15 to 35 C. Output wattage is 50 w, adjustable from 0 to 115 v. Operating temperature is −50 C to +50 C. **Circle 446 on Reader Service Card.**



Temperature Controller
on-off type

ELECTRONIC PROCESSES CORP. OF CALIFORNIA, 2190 Folsom St., San Francisco 10, Calif. A new electronic on-off temperature controller offers as an optional feature an anticipating section which provides a close, stable control over temperatures of industrial processes. Also featured are plug-in, epoxy-potted electronic circuits which are dust

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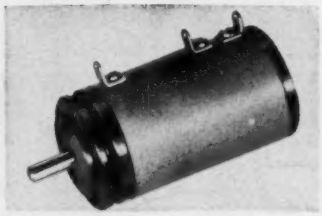
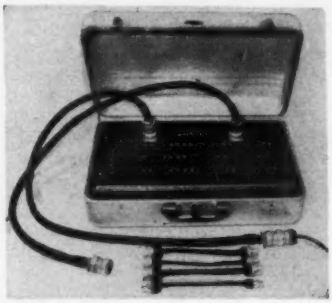
and moisture proof, and less subject to damage due to vibration. This plug-in circuitry also permits rapid in-plant servicing by nontechnical personnel. **Circle 447 on Reader Service Card.**



Precision Pot
10-turn device

SPECTROL ELECTRONICS CORP., San Gabriel, Calif. Model 870 10-turn precision wire wound pot is available in ranges from 30 to 750 K ohms and with a standard linearity tolerance of ±0.3 percent. Linearity tolerance of ±0.02 percent is available on special order. Unit features precision ball or sleeve bearing mounts at both shaft ends, machined aluminum lids for either bushing or servo type mounting. The body is made of moisture proof laminated phenolic for maximum dimensional stability and insulation resistance and is 1 7/16 in. in diameter. **Circle 448 on Reader Service Card.**

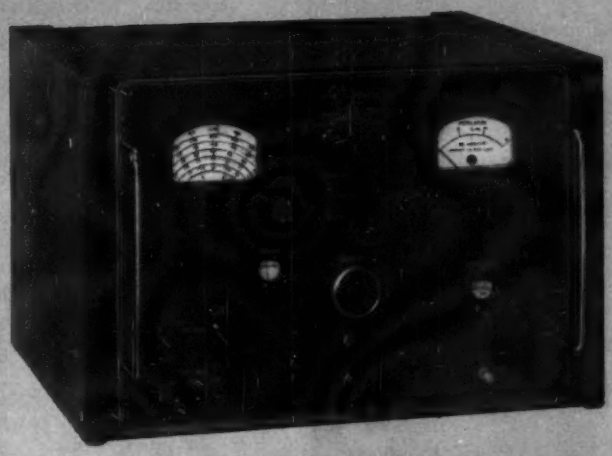


Circuit Analyzer
for aircraft

SCOTT INSTRUMENT CO., 3734 W. Slauson Ave., Los Angeles 43, Calif. The new circuit analyzer is a 37 and 61 circuit instrument which helps promote the flight safety factor. It makes it possible to check instantly the operational factors of all air-

New design features make this the ideal general purpose Signal Generator

BRC TYPE 225-A provides these unique advantages:



- RF settability better than ±0.05%
- RF stability 0.001% for 5 minutes, 0.001% for 5 volt line change
- Extremely low incidental FM 0.001% at 30% AM
- FM modulation from external oscillator

SPECIFICATIONS

RF Range:
10 to 500 mc

RF Accuracy:
±0.5% (after two hour warmup)

RF Output:
RANGE:
0.1 μv to 0.1 volts (across external 50 ohm load)
ACCURACY:
±10% 0.1 to 50 K μv, 10 to 250 mc
±15% 0.1 to 50 K μv, 250 to 500 mc
±20% 0.05 to 0.1 v, 10 to 500 mc

AM Range:
0 to 30%

AM Accuracy:
±10% at 30% AM, 10 to 250 mc
±15% at 30% AM, 250 to 500 mc

AM Distortion:
5% 10 to 250 mc
7% 250 to 500 mc

Incidental FM:
0.001%, or 1000 cps, whichever is greater, at 30% AM

FM Range:
0 to between 5 kc and 60 kc deviation, depending upon frequency, in the range 130 to 500 mc (from external oscillator)

Pulse Modulation:
From external source

Pulse Rise Time:
<5 μsec 10 to 40 mc
<3 μsec 40 to 80 mc
<2 μsec 80 to 500 mc

Pulse Overshoot:
<10% 10 to 100 mc
<25% 100 to 500 mc

Modulating Oscillator:
400 and 1000 cps ± 10%

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This new BRC signal generator is an outgrowth of a quarter century of experience in the design of precision electronic instruments. Ruggedly constructed for stability, reliability, and extremely low leakage, this instrument incorporates a backlash-free gear drive and a precision machined piston attenuator. Complete shielding is provided in the MOPA circuit by mounting the oscillator and amplifier in separate aluminum castings. By simply removing cabinet end bells, it is suitable for 19" rack mounting; an important feature for system applications. Because of its unique FM modulation above 130 mc, it also provides for testing and calibrating FM communication systems in the 160 and 450 mc bands. Price: $945. F.O.B. Boonton, N. J.

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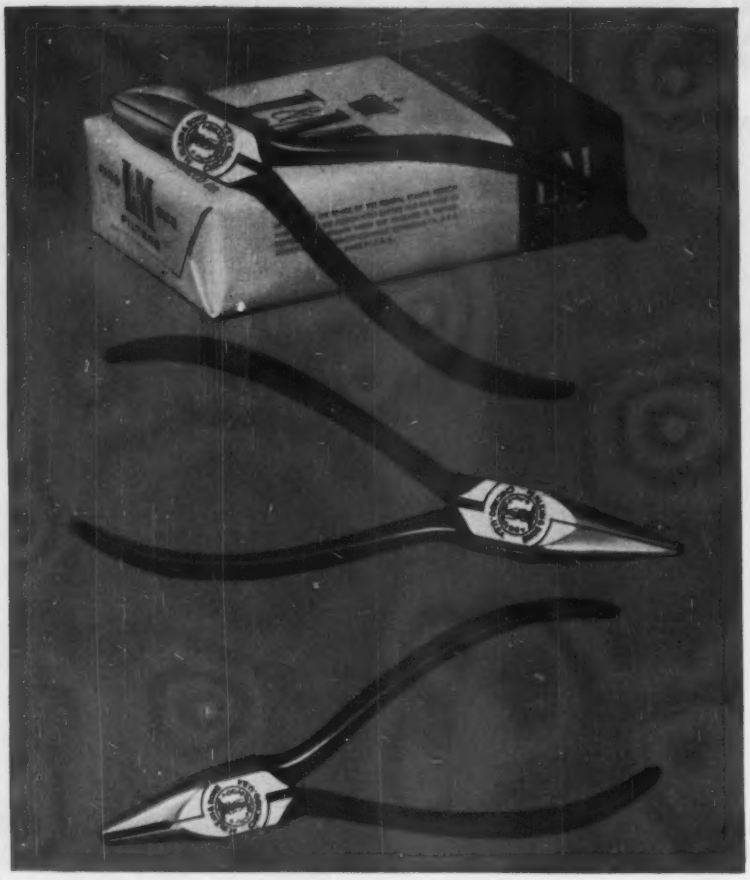


KLEIN midget pliers speed up electronic assemblies

Hardly larger than a package of your favorite cigarettes, these Klein midget pliers fit into small spaces, simplifying wiring on electronic assemblies.

Midgets in size but giants in performance, they make it easy to work in confined space.

These midgets are recent additions to the famous Klein line of high-quality pliers. Scores of long nose, side cutters, oblique cutters and other types are illustrated and described in the Klein catalog. A copy will be sent without obligation.

FREE KLEIN CATALOG

Catalog 101A, listing and describing scores of Klein Pliers, will be sent on request. Write for it today.

ASK YOUR SUPPLIER

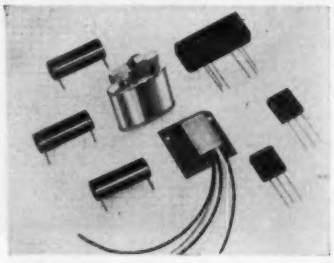
Foreign Distributor: International Standard Electric Corp., New York

Mathias KLEIN & Sons
Established 1857 — Chicago, Ill., U.S.A.
7200 McCORMICK ROAD • CHICAGO 45, ILLINOIS

craft circuits in all planes using Deutsch connectors. This helps reduce grounding time, cuts down on delays between flights, results in reduced servicing time and possible reduction of spares in stock. **Circle 449 on Reader Service Card.**

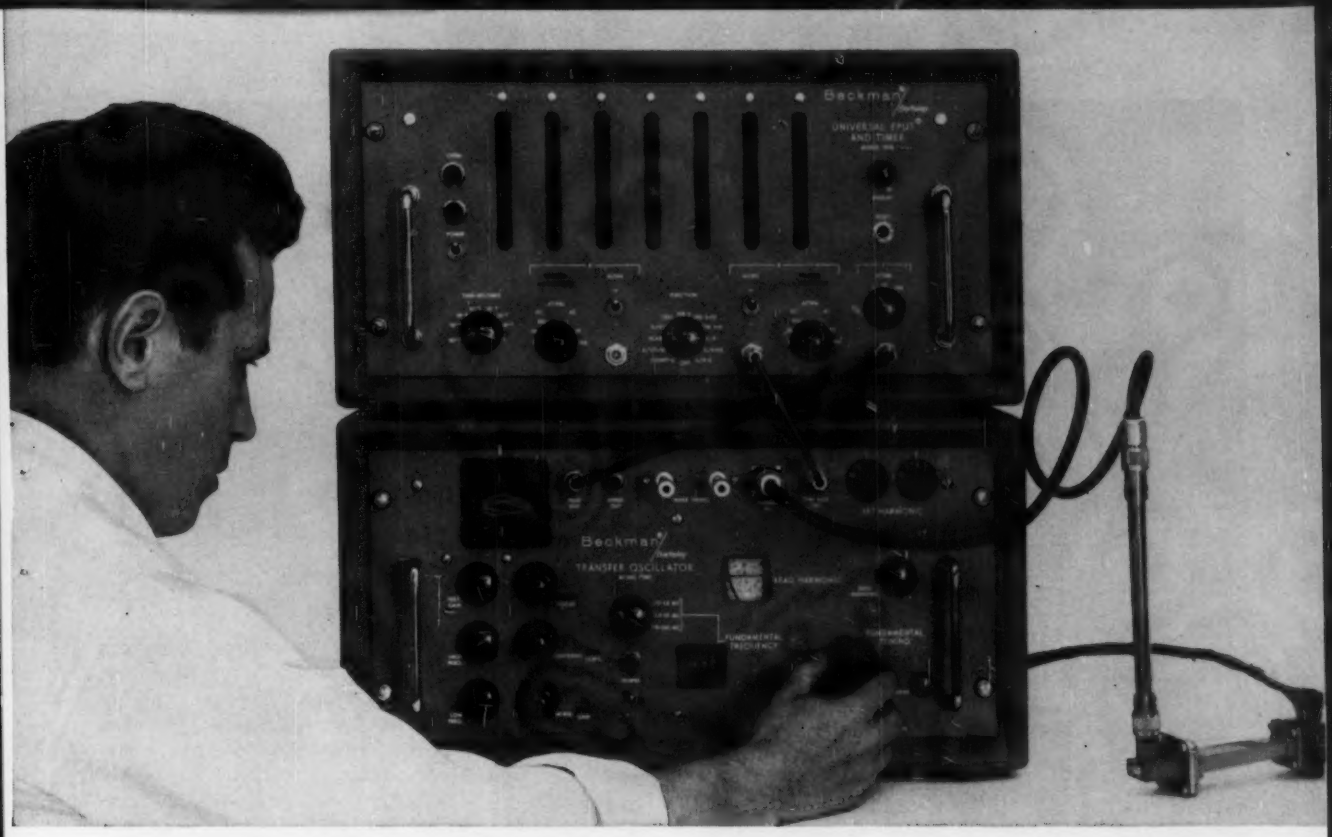
Cathode Coating for electron tubes

SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa., announces a new development in electron tube manufacture that promises greatly improved performance by many types of electronic equipment. "Sarong" is a skin-tight film coating wrapped around the tube cathode. Every active portion of the cathode surface receives a skin-tight bonded film of uniform quality and texture. With sprayed cathode coating, uniformity of distribution, thickness and weight is harder to achieve, firm says. **Circle 450 on Reader Service Card.**



Matched Sets and networks

ULTRONIX, INC., 116 South Bayshore Blvd., San Mateo, Calif. Close tolerance matched resistor sets and networks are now being manufactured. Available in a wide range of values, networks and sets are made with ratios matched as closely as 0.001 percent and absolute values within 0.01 percent. An example of current production is a ratio set of 13 re-



12,000 Mc

directly displayed by a counter

Model 7580 Transfer Oscillator (bottom cabinet) with Model 7370 EPUT and Timer (top cabinet):

Frequency measuring range	dc to 12 K Mc
Types of signals accommodated	CW, AM, FM pulsed r-f
Sensitivity	100 mv rms
Input impedance	50 ohms
Accuracy	up to $\pm 3p$ in 10^7
Fundamental range of trans. osc	75 to 150 Mc & 7.5 to 15 Mc
Harmonics available	Up thru 80th
Stability of fundamental	.0001%/min

Four-step operation:

1. Tune to two adjacent zero beats identified by built-in oscilloscope display.
2. Read harmonic number on calculator dial.
3. Set rotary switches to harmonic number.
4. Read frequency indication directly from counter.

Prices: Model 7580 Transfer Oscillator . . . $1650
Model 7370 10 Mc EPUT & Timer . . . $1975
Model 7360J 2 Mc EPUT & Timer (price $1325) may also be used with the transfer oscillator.

158

Used in combination with the computing transfer oscillator in the cabinet beneath it, the 10 Mc EPUT® and Timer creates a *direct* decimal display of 12,243.15 megacycles generated by the small klystron at the right. How? The transfer oscillator contains a computing device which automatically calculates the harmonic number of a harmonic brought to zero beat with the frequency under test. Then, the gate time of the counter is multiplied by the harmonic number to produce a counter indication of actual klystron frequency. By eliminating all manual computations, the entire operation commonly takes less than one-fifth the time required using equipment previously available.

This assembly of two independent units, compatibly designed, offers an unprecedented combination of range, accuracy and convenience. The transfer oscillator can also be used with either of two other BECKMAN/Berkeley EPUT Meters currently in wide use.

For more information on this and other recent advances in digital frequency measuring techniques, write for the new Data File 111. Address department G-3.

Beckman®

Berkeley Division
2200 Wright Avenue, Richmond 3, California
a division of Beckman Instruments, Inc.

CIRCLE 235 READERS SERVICE CARD

Suppressor grid vanes guide electrons into beams, provide higher power output at lower plate voltages.
Heat-radiating fins on plate are aligned with beams, provide maximum cooling at points of highest heat intensity.
Suppressor grid terminates in base shell, may be grounded in most applications.
One-piece, low-loss plate seal and cap is extremely rugged, resists seal leakage or damage, won't break off.
Base pin connections arranged for easy substitution of tube in equipment having old-type screen grid tubes.
PL-175

NEW PENTA MEDIUM POWER BEAM PENTODE

— higher output at low plate voltages, improved cooling

Now Penta Laboratories brings to the 500- to 1000-watt output range the advantages of the exclusive vane-type suppressor grid introduced in 1956 with the 1000-watt PL-172. This new 400-watt PL-175 provides 25 to 30% higher output in Class AB_1 linear amplifiers than tetrodes with similar ratings — with minimum distortion. A versatile tube, the PL-175 also has outstanding advantages as a Class C r-f power amplifier or high power audio amplifier for modulator service.

RATINGS

Heater voltage	5.0 volts	Plate current, max.	350 ma.
Heater current	14.5 amps	Plate dissipation, max.	400 watts
Plate voltage, max.	4000 volts	Grid-Screen Mu	5

A COMPLETE LINE OF HIGH-EFFICIENCY TUBES—write for technical data on the PL-175 or see your local distributor

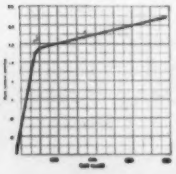
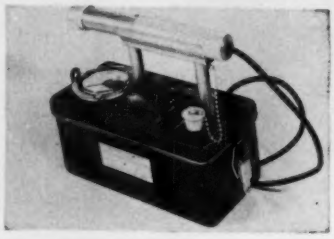


Plate current curve at zero grid voltage shows why the PL-175 gives high power gain and operates efficiently at low plate voltages.

ASK FOR A FREE COPY of "Transmitting Tubes for Linear Amplifier Service." This nine-page bulletin discusses linear amplifier tube requirements in detail. Graphs, characteristic curves, oscillograph linearity patterns and data show why Penta's exclusive beam pentode designs outperform four-element tubes.

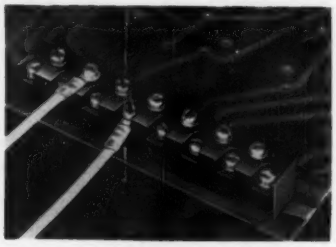
PENTA *laboratories, inc.*
316 N. Nopal St., Santa Barbara, Calif.

sistors, each matched to the master resistor within 10 parts per million with absolute resistance values held to within 0.01 percent. **Circle 451 on Reader Service Card.**



Survey Meter transistorized

UNIVERSAL TRANSISTOR PRODUCTS CORP., 17 Brooklyn Ave., Westbury, L. I., N. Y., has designed a highly accurate transistorized, portable, light weight, alpha-beta-gamma survey monitor. It operates exclusively from inexpensive standard flashlight batteries. Circuitry of the UAC 408 employs 1½-v "D" cells and features a thin mica end window G-M tube—thickness of 1.4-2 mg/cm²—useful in carbon 14 and sulphur 35 monitoring. **Circle 452 on Reader Service Card.**



Terminal Block for p-c boards

KULKA ELECTRIC CORP., 633 So. Fulton Ave., Mt. Vernon, N. Y., announces a miniature terminal block that mounts on printed-circuit boards. Type 520 eliminates soldering. Instead, it provides screw connections integral with terminal pins that slip into standard connector mounting holes in the p-c board. The entire connector unit is securely mounted and connected by dip soldering the pins passing down to the underside of the board. The entire p-c board, with terminal block and

"Designed for Application" • Oscilloscopes and Accessories

The extensive Millen "Designed for Application" line of oscilloscopes and accessories includes five instrumentation oscilloscopes, six rack mounted basic oscilloscopes, an insulated industrial oscilloscope, a miniature synchroscope-oscilloscope, two compact rack mounted complete oscilloscopes, a rack mounted basic oscilloscope for military applications, two amplifier-sweeps, and a plug-in power supply.

INSTRUMENTATION OSCILLOSCOPES

Miniaturized, packaged panel mounting cathode ray oscilloscopes designed for use in instrumentation in place of conventional "pointer type" moving coil meter. Magnitude, phase displacement, wave shape, etc. are readily displayed.

No. 90901 uses type 1CP1 fixed focus one inch cathode ray tube. 2 11/16" x 2 3/4" panel. Panel bezel matches in size and type the standard 2" square meters.

No. 90911 uses Type 1EP1 cathode ray tube. Balanced deflection. Blanking input. Sharp focus. Panel matches 2" square meters. Flat face RCA 1¼" diameter tube.

No. 90912 uses type 2BP1 two inch cathode ray tube. 3" x 5" panel. Sharp focus. Good sensitivity. Accelerating voltage 500 to 875 volts. Min. control interaction.

No. 90912-R uses type 3UP1 2½" x 1⅝" rectangular cathode ray tube.

No. 90913 uses type 3XP1 3" x 1½" rectangular cathode ray tube. 1⅝" x 2¾" useful scan. Vertical sensitivity 33 volts d.c. per inch at 2000 v. accelerating.

BASIC OSCILLOSCOPES

Rack mounted inexpensive *basic* oscilloscopes including cathode ray tube circuit, power supply; intensity, focus, and centering controls, magnetic shielding, safety features, switches, etc. The *basic* oscilloscopes in their packaged form are entirely adequate for many laboratory as well as industrial and communication uses.

No. 90902 uses type 2BP1 two inch cathode ray tube. 3½" x 19" panel. Power supply — 105–125 volts — 60 cycles. Power consumption — 19 watts.

No. 90902-M — Military version of 90902.

No. 90903 uses type 3KP1 three inch cathode ray tube. 5¼" x 19" panel. Power supply — 105–125 volts — 60 cycles. Power consumption — 19 watts.

No. 90903-R uses type 3XP1 3" x 1½" rectangular cathode ray tube. 3½" x 19" panel. Power supply 105–125 volts — 60 cycles.

No. 90905 uses type 5UP1 five inch cathode ray tube. 7" x 19" panel. Power supply 105–125 volts — 60 cycles. Power consumption — 32 watts.

No. 90905-B uses type 5ADP1 five inch flat face precision tolerance cathode ray tube. Power supply — 105–125 volts — 60 cycles. Power consumption — 35 watts.

No. 90905-R uses type B1204 4 5/16" x 2 5/8" rectangular cathode ray tube. 3½" x 19" panel.

INDUSTRIAL OSCILLOSCOPE

Suitable for use in factory, laboratory, and the field for design, installation, maintenance, and service. Completely insulated front panel and case. Double shielded against magnetic fields. Excellent linearity. Sharp focus over entire 4" x 4" useful scan. The vertical and horizontal amplifiers are stable d.c. amplifiers and are identical, thus permitting accurate phase measurements.

No. 90915 uses type 5AQP — 1, 2, 7, or 11 flat face, precision tolerance cathode ray tube. Frequency response of either amplifier D.C. to 100 K.C. + 0–10%.

MINIATURE SYNCHROSCOPE-OSCILLOSCOPE

Compact "field service" Synchroscope or Oscilloscope. 7½" x 5¾" x 13". Weighs 17 pounds. Synchronizes to internal or external positive or negative pulses. Band width 10 cycles to 1000 KC. Sweep 6 to 300 microseconds per inch. Performance has not been sacrificed in designing this unit for light weight.

RACK MOUNTED OSCILLOSCOPES

Complete with amplifiers and sweep. Good low frequency response and linearity. For monitoring, production test, or laboratory use. Compact.

No. 90923 uses type 3XP1 3" x 1½" rectangular cathode ray tube. 3½" x 19" panel.

No. 90925 uses type B1204 4 5/16" x 2 5/8" rectangular cathode ray tube. 3½" x 19" panel.

PLUG-IN POWER SUPPLY

Compact high voltage power supply for oscilloscopes, etc. 2" x 2½" x 5". Input 117 volts 50/60 cycles at 10 watts. Output 750 volts d.c. at 3 ma. and 6.3 volts a.c. at 600 ma. Supplies accelerating and centering potential for oscilloscopes.

No. 90202 Power Supply for Instrumentation Oscilloscopes.

AMPLIFIER/SWEEP UNITS

Horizontal and vertical amplifiers and sawtooth sweep generator for use with *basic* oscilloscopes. Match MILLEN *basic* oscilloscopes in appearance.

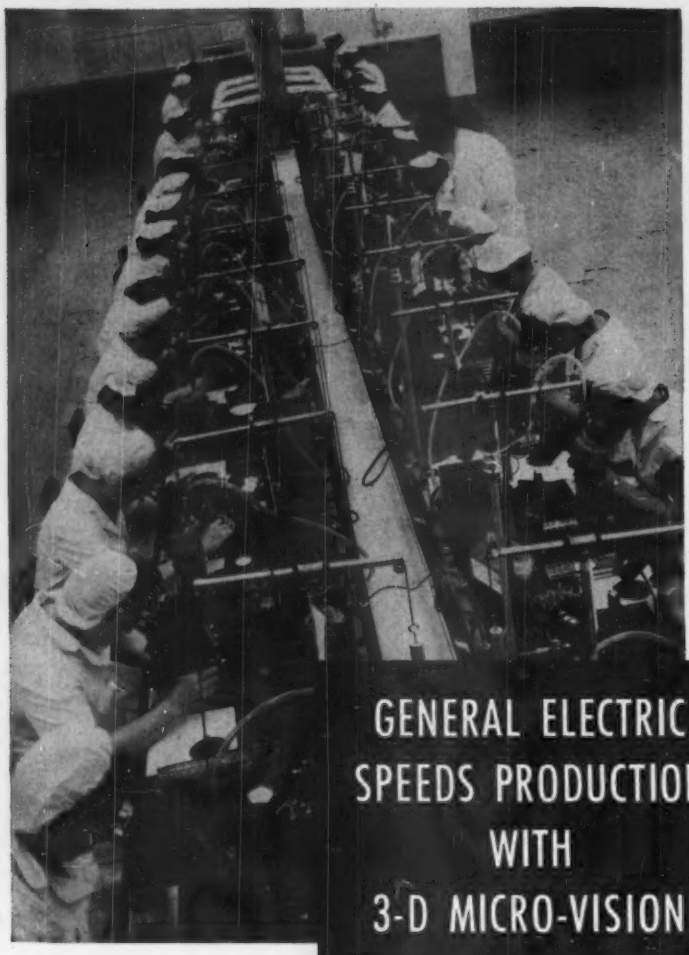
No. 90921 — 6SJ7 amplifiers. 6SN7-GT hard tube sweep. 5¼" x 19" rack panel.

No. 90922 — 3½" x 19" rack panel. Good low frequency linearity.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY

MALDEN, MASSACHUSETTS, U.S.A.



How B&L Stereomicroscopes help in assembly of ultra-precision transistors

These skilled operators are doing a job that "just couldn't be done without stereomicroscopes," according to Norman Spoonley, foreman, Semiconductor Products Dept., General Electric Co., Buffalo. This critical phase of transistor assembly involves soldering a 1-mil nickel wire between a nickel tab and the .6-mil core of a .1" germanium pellet which, in turn, is fused between two 5-mil nickel wires. B&L Stereomicroscopes make it possible by showing enlarged views in natural 3D. Air-tight, dust-free design keeps images sharp, clear, undistorted . . . for full-working-day efficiency without visual fatigue. In assembly, quality control, inspection, some 100 B&L microscopes help G. E. mass-produce to highest precision standards. If you have small-parts assembly and inspection problems, you need B&L Stereomicroscopes.

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70939 St. Paul Street, Rochester 2, N. Y.

☐ I'd like to borrow a B&L Stereomicroscope for 15-day trial without cost or obligation.

☐ Send me Stereomicroscope Catalog D-15.

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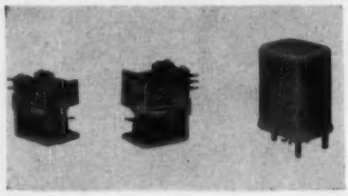
Title .....
Company .....
Address .....
.....

lead wires, can be encapsulated if desired. It is available in 2 to 24 terminals. **Circle 453 on Reader Service Card.**



Relays
three types

THE CARDINAL CONTROL CO., Meadow St., New Britain, Conn. A new line of electrical relays includes: C.R., rated 5 amperes, available up to 4 pdt; C.P., rated at 10 amperes, dpdt; and C.S., a sensitive unit with sensitivity suitable for operation in the plate circuit of vacuum tubes, going down as low as 50 mw. All are available open or hermetically sealed. New features are tapered arms for distributed stress; Nylon bobbins for durable, long service. **Circle 454 on Reader Service Card.**

Power Ferrite
for low frequencies

ALLEN-BRADLEY CO., 136 W. Greenfield Ave., Milwaukee 4, Wisc. A new power ferrite with an almost perfectly rectangular hysteresis loop that provides high-efficiency operation in the frequency range from 400 cps to 15,000 cps has been announced. The low hysteresis loss and negligible eddy current loss of the R-03 ferrite permits operation at frequencies where, firm says, other materials are impractical. **Circle 455 on Reader Service Card.**

Beam Power Pentode
four versions

CBS-HYTRON, Parker St., Newburyport, Mass. The 6-, 12-, 25- and 50-EH5 are four versions of a new

Cat. No. 867-A

KAY *Vari-Sweep*

MODEL 400

ALL-ELECTRONIC, HIGH LEVEL SWEEPING OSCILLATOR, 15-470 mc, or *(with sweep off)* Continuously Tuned CW Signal Source

- **Fundamental Frequency—Stable Narrow Band Sweeps**
- **Direct Reading Frequency Dial**
- **Highly Accurate Attenuators**
- **Sweep Repetition Rates Down to 10 cps**

The new *Vari-Sweep Model 400* is a highly versatile laboratory sweeping oscillator and signal generator. Its wide range of continuous frequency coverage from 15 to 470 mc is combined with a measure of accuracy and level of performance previously associated with limited, fixed-frequency-band oscillators only.

It provides frequency sweeps that are flat, wide, and linear. The RF output voltage is high enough for testing lossy networks without using additional amplifiers. Over the entire range, the RF output is a fundamental frequency held constant by a fast-acting AGC circuit to assure a high degree of frequency stability and the absence of spurious beat signals. The variable sweep rate goes down to 10 cps for checking high-Q circuits.

In addition, the *Vari-Sweep Model 400* is a source of accurately calibrated CW signal with the same high-level output AGC'd to be constant over the frequency band. This eliminates the need for readjusting output voltage when changing frequency, and permits the rapid testing of diverse frequency circuit elements under CW conditions.

SPECIFICATIONS

Frequency Range (CW or Sweeping Operation): Fundamental frequency, 15-470-mc, continuously variable in 10 switched, overlapping bands with direct-reading frequency dial.

Sweep Width: 60% of center frequency to 50 mc; at least 30 mc max from 50-400 mc; approx. 20 mc max above 400 mc.

Sweep Rate: Continuously variable, 10 to 40 cps; locks to line frequency.

RF Output: 1.0 V rms (metered) into nom 70 ohms (50 ohms on request) to 220 mc; 0.5 V rms to 470 mc. Output held constant to within ±0.5 db over widest sweep and frequency range by AGC circuit.

Attenuators: Switched 20, 20, 10, 6 and 3 db, plus continuously variable 6 db.

Sweep Output: Regular sawtooth, synchronized with sweeping oscillator. Amplitude 7.0 V approx.

Power Supply: Input approx. 100 watts, 117-V (±10%), 50-60 cps ac. B+ electronically regulated.

Dimensions: 9⅛" x 19½" x 13".

Weight: 34 lbs.

Price: $795.00, f.o.b. factory.

NEW

KAY

ROTARY SWITCHABLE

Attenuator

- **High Frequency Switches—Solid Silver Contacts Set in Teflon**
- **Improved Accuracy—Near Zero Insertion Loss**
- **Precision Carbon Film Resistors**
- **Flat Frequency Response**

SPECIFICATIONS

Input and Output Impedances: *Model 50-0*—50 ohms nom; *Model 51-0*—70 ohms nom; *Model 52-0*—90 ohms nom.

Db Switched: 0-119 in 1 db steps controlled by two rotary switches graduated in 10 db and 1 db steps.

Insertion Loss: Zero db at low frequencies; approx 0.1 db at 250 mc; approx 0.2 db at 500 mc.

Accuracy: Max. total error (including insertion loss) at full attenuation = 1.0 db up to 250 mc, 2.0 db 250-500 mc.

Frequency Range: DC to 500 mc (useful to 1000 mc).

SWR: Max. of 1.2:1 up to 250 mc; max. of 1.4:1 250-500 mc.

Maximum Power: ½ watt.

Dimensions: 5" dia. x 3" deep.

Weight: 4¼ lbs.

Price: $195.00, f.o.b. factory.

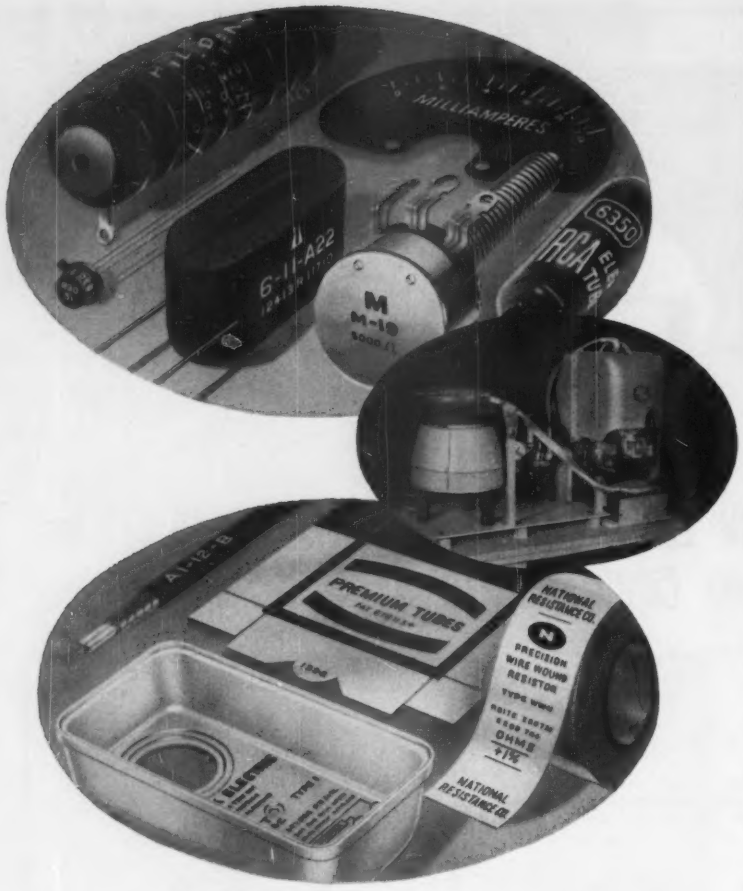
SEE US AT THE IRE SHOW, BOOTHS 2608-09 and 3025-26

Dept. E-3

Write for New Kay Catalog

KAY ELECTRIC COMPANY

MAPLE AVENUE PINE BROOK, NEW JERSEY CApital 6-4000



make *all* your marking *clear... complete... lasting...*

WITH A JOB-PROVED METHOD AND MACHINE FROM *MARKEM*

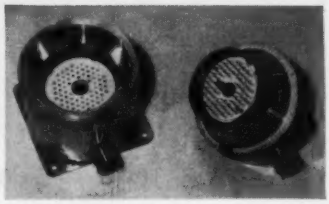
If new products present unusual marking problems, or you'd like to improve your regular day-to-day marking operations, Markem can give you just the help you need. For example, Markem can show you how to automatically feed and imprint *both* the periphery and top of JETEC 30 case units... maintain high production with frequent imprint changes... position "hard-to-hold" components for exact marking... achieve sharp, readable imprints in small areas or on uneven surfaces... color band at high speed with close registration ... assure durability in pre-assembly marking. These – along with hundreds of "standard" jobs – are being done by Markem machines every day.

Markem equipment in your plant provides the marking clarity, durability and speed you need – and often at considerable savings. Get specific help now with *your* requirement, based on nearly 50 years of Markem experience in industrial marking. And ask for a copy of the "Electrical/Electronics" catalog describing 24 Markem machines for marking cylindrical, flat and irregular shapes; tubing, wire, tapes and labels. Write Markem Machine Co., Keene 5, New Hampshire.

MARKEM

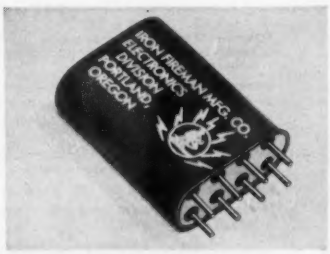
EVERYTHING INDUSTRY NEEDS... FOR PROFITABLE MARKING... SINCE 1911

beam power pentode. A compact 7-pin miniature, it offers high power sensitivity at extremely low plate and screen supply voltages. For example, a peak a-f input voltage of 3 v provides 1.4 w output with supply voltages of only 110 v, plate, and 115 v, screen. Heater currents of the four types are 1.2 amperes, 600 ma, 300 ma and 150 ma, respectively. **Circle 456 on Reader Service Card.**



Connectors high temperature

ANDERSON ELECTRIC CORP., Birmingham 1, Ala., announces a new series of high temperature electrical connectors for use in high radiation areas. Designed for use with remote handling equipment, the connectors are available with various pin combinations up to 250 contacts. As a manipulator has no sensory feel, allowances have been made for misalignment up to $\frac{3}{4}$ in. and/or 15 deg when mating the plug and receptacle. **Circle 457 on Reader Service Card.**



Crystal Can Relays low sensitivity

IRON FIREMAN MFG. CO., 2838 S.E. Ninth Ave., Portland 2, Ore., announces a new series of crystal can relays with sensitivity as low as 25 mw (spdt) and 40 mw (dpdt) requiring no polarized operating power. Designated as R800-DP-DT

MASSA Presents..... 12 Channel RECTILINEAR RECORDER

MODEL RE-12
FOR 19" RACK MOUNTING

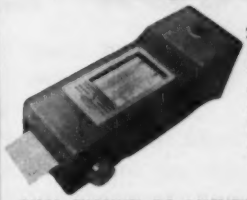
RECORDER ELEMENT, MODEL M-133A
Sensitivity: 20 ma rms full scale.
Impedance: 1000 ohms nominal
Dimensions: 4⅛"Lx3"Hx1¼"W.
Weight: 1¼ lbs.

This new direct writing recorder has been developed to meet current demands for a compact, multichannel, high quality instrument incorporating the following features.—

- True rectilinear motion.
- Ink or electric writing.
- Excellent transient response, free of resonant peaks, overshoot, and ringing.
- Wider frequency range, DC to 200 cps.
- Push button selection of 18 chart speeds: ½ cm/hr to 200 mm/sec.
- Event Marker provides automatic one second markings.
- Remote operation with convenient plug-in control unit.
- Footage Indicator shows remaining amount of chart in recorder.
- Dimensions, 19" wide x 12¼" high x 16" deep. Weight 56 lbs.

Write for RE-12 Product Data Sheet

AVAILABLE EQUIPMENT AND ACCESSORIES



2 CHANNEL RECORDER MODEL GA-1023 — Compact, lightweight recorder, for ink or electric writing, employs two M-133 oscillographs. 3 Speeds 2, 20, 200 mm/sec. Dimensions 13"L x 4⅜"W x 4½"H. Weight: 9 lbs.

DUAL CHANNEL DC AMPLIFIER MODEL M-220 — A high gain stabilized amplifier for operating all Massa Recorders over range dc to 200 cps. Sensitivity ranges, 12 steps, 5 mv/mm to 20 v/mm.

RECORDER ACCESSORIES — Electric Power Supplies for electric writing. Chart rolls with true rectangular coordinates for ink and electric writing. Pens for ink or electric writing.

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HINGHAM, MASSACHUSETTS

after 60 years

the electronics industry votes a solid "YES!"

Kester Solder

Take a walk along most any assembly line anywhere in the electronics industry . . . and what do you see? KESTER FLUX-CORE SOLDER . . . the standard today as it's been for many years. Manufacturers and engineers know they can depend upon Kester to protect their products' reputation. Let it do the same for you!

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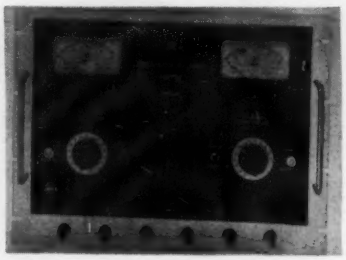
4204 Wrightwood Avenue, Chicago 39, Illinois
Newark 5, New Jersey Brantford, Canada

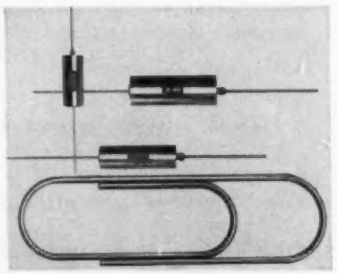
OVER 60 YEARS' EXPERIENCE IN SOLDER AND FLUX MANUFACTURING

and RS800-SP-DT, the microminiature relays will meet military specifications requiring vibration immunities of 20 g's up to 2,000 cps and shock immunities of 100 g's. Minimum life is rated as 100,000 operations at 125 C while carrying contact loads of 2 amperes at 115 v rms and 28 v d-c. **Circle 458 on Reader Service Card.**



Voltage Supplies
precision units

JULIE RESEARCH LABORATORIES, INC., 556 W. 168th St., New York 32, N. Y., has available two new secondary-standard reference power supplies, providing 50 to 100 times higher voltage levels than standard cells, at a current capacity permitting direct loading by practical circuits, and at accuracies at least equivalent to an unsaturated standard cell. Model PVS-105A has a dual output of ±50 v, or 100 v if used end-to-end. Model PVS-105B provides ±36 v, or 72 v, end-to-end. **Circle 459 on Reader Service Card.**



Tantalum Capacitors
solid electrolyte

ASTRON CORP., 255 Grant Ave., East Newark, N. J., has available a complete line of subminiature, metal-cased hermetically sealed capacitors designated as type TES with a solid tantalum dielectric and solid elec-

We ended chemical dangers and increased production **WHEN WE...**

STOPPED *making our own etchant and* **STARTED** *using* **HUNT S.C.E.**

"We made our own etchant for plated circuit boards until we heard about HUNT S.C.E. Solution.

"It took time to mix up large quantities of chromic and sulphuric acid into an etching solution which gave off noxious fumes and was dangerous to handle. It varied from batch to batch and had to be heated to 140° F. to etch properly.

"So we did the wise thing . . . stopped mixing our own solutions and switched to Hunt S.C.E. . . . No more chemical dangers and we're saving money too . . . we etch at a uniform rate around the clock. HUNT S.C.E. (Solder Circuit Etch) is best for your plant too because it:

1. Etches rapidly at room temperature.
2. Has high capacity for copper.
3. Never attacks the solder-plated circuit.
4. Gives fast, odorless etching of copper.
5. Produces boards that pass all corrosion and stability tests.
6. Is a prepared solution with guaranteed uniformity and rigid laboratory control.

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For detailed information about HUNT S.C.E. and valuable production handling information, write for Technical Bulletin No. 3— "The Etching of Solder Plated Circuit Boards by Hunt S.C.E. Solution."

PHILIP A. HUNT COMPANY

PALISADES PARK NEW JERSEY

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In Canada: Philip A. Hunt Company (Canada) Ltd., 77 Leslie St., Toronto

CIRCLE 243 READERS SERVICE CARD

the ultimate in bandpass filters

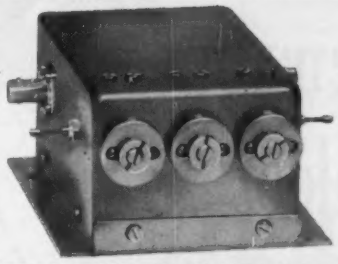
Model HFF-4
(Quadruple Tuned)

$f_o = 400$ mcs
B.W. = 45 mcs
Insertion loss = 0.9 db

SPECIFICATIONS

MODEL HFF BANDPASS FILTERS

Center Frequency:	30 to 1000 mcs (factory preset to customer specifications)
Bandwidth:	5% to 25% of center frequency (factory preset)
Impedance:	50 ohms
V.S.W.R.:	≦ 1.3 in pass band (consistent with peak to valley ratio)
Insertion Loss:	≦ 1 db
Peak to Valley Ratio:	≦ .5 db
Selectivity:	Defined by number of resonant elements Doublets to sextuplets available
Power Rating (CW):	25 watts
Connectors:	BNC or Type N
Finish:	Silver Plate; Rhodium Flash



Model HFF-T-3
(Triple Tuned)

$f_o = 425$ mcs
B.W. = 50 mcs
Insertion loss = 0.15 db

SPECIFICATIONS

MODEL HFF-T BANDPASS FILTERS

Center Frequency:	200 to 2000 mcs (factory preset to customer specifications)
Bandwidth:	1% to 15% of center frequency (factory preset)
Impedance:	50 ohms
V.S.W.R.:	≦ 1.2 in pass band (consistent with peak to valley ratio)
Insertion Loss:	≦ 1 db
Peak to Valley Ratio:	≦ .5 db or less
Selectivity:	Defined by number of resonant elements Doublets to sextuplets available
Power Rating:	100 watts
Connectors:	BNC or Type N
Finish:	Silver Plate; Rhodium Flash

Model HFF and Model HFF-T bandpass filters are available at other frequencies, bandwidths, power ratings and to customer specifications. Also available are temperature compensated filters for maximum stability.

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Newest catalogs furnished on request:

No. 657 A. Compression Multi-Headers & Plugs.

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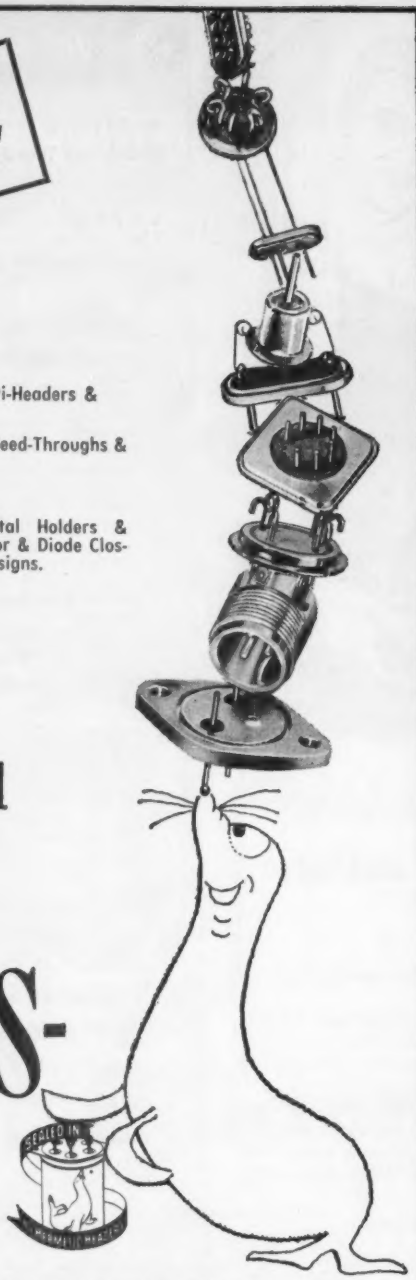
No. 657 C. AN Connectors

No. 657 D. End Seals, Crystal Holders & Mounts, Transistor & Diode Closures, Custom Designs.



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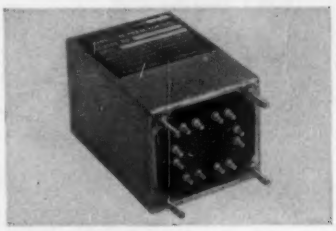
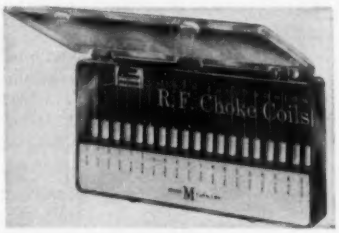
trolyte. The sturdy, vibration resistant units, which can never leak or corrode because of their solid nature, are used in miniaturized circuitry where high capacity and small size are required for computers, aircraft, missiles, transistorized circuits and portable equipment of all kinds. **Circle 460 on Reader Service Card.**



Phase Shifter high sensitivity

VECTROL ENGINEERING, INC., P. O. Box 1089, Stamford, Conn., announces the series 901 phase shift network for proportional control of thyratron outputs up to 20 kw, with a d-c control signal of 1 mw. Typical applications are: regulated power supplies, adjustable speed motor drives, programmed speed controls, servo motors and machine-tool automation. **Circle 461 on Reader Service Card.**



R-F Choke Kits series of three

ESSEX ELECTRONICS, 550 Springfield Ave., Berkeley Heights, N. J. A total of 63 chokes, in the preferred series of inductance values, are attractively packaged in 3 handy clear-plastic boxes to aid the design engineer in the immediate selection of choke parameters for any specific design condition. Series S kit contains 19 chokes in an inductance range of 0.1 μh to 100 μh; series M, 19 chokes from 1.0 μh to 1,000 μh;

Send for FREE SAMPLE PACKET of the three new
MUELLER "70 SERIES" ALLIGATOR CLIPS
Low-cost, streamlined clips
with **SNAP!**

THIS IS AN ACTUAL
HIGH SPEED SEQUENCE PHOTOGRAPH
OF A NEW "70 SERIES" ALLIGATOR CLIP

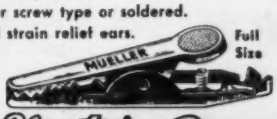
which is taking 1/2500th second to snap shut upon a wafer. Talk about acceleration!—the upper jaw hits 60 MPH in three-eighths of an inch. The upper jaw and flying wafer fragments have been caught in many images along their paths of movement.

Photographed by means of a special process, it graphically illustrates the "snap" in Mueller's traditionally snappy springs. These springs provide a mean, corrosion-cutting bite for perfect test connections.

THE NEW "70 SERIES" ALLIGATORS FEATURE:

Simple, direct, streamlined design, and lower cost than the famous "60 Series".
Faster, easier connection, whether screw type or soldered.
A new patented hinge, and cord strain relief ears.

WRITE FACTORY TODAY FOR FREE SAMPLE PACKET SHOWN ABOVE



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Portland, Oregon

A manufacturer of universal recognition in cathode ray oscilloscopes and allied instrumentation, Tektronix is continually seeking to advance the oscilloscope art. To this end we rely on internal design of fundamental components as well as complete instruments.

Creative physicists and engineers with experience in vacuum and cathode-ray tube design, semi-conductor research, and circuit design will be interested in a program of major expansion in our Engineering Division.

For further information please contact Mr. Robert Mitchell, Barbizon-Plaza Hotel, New York City, March 20, 21 and 23 through 27.

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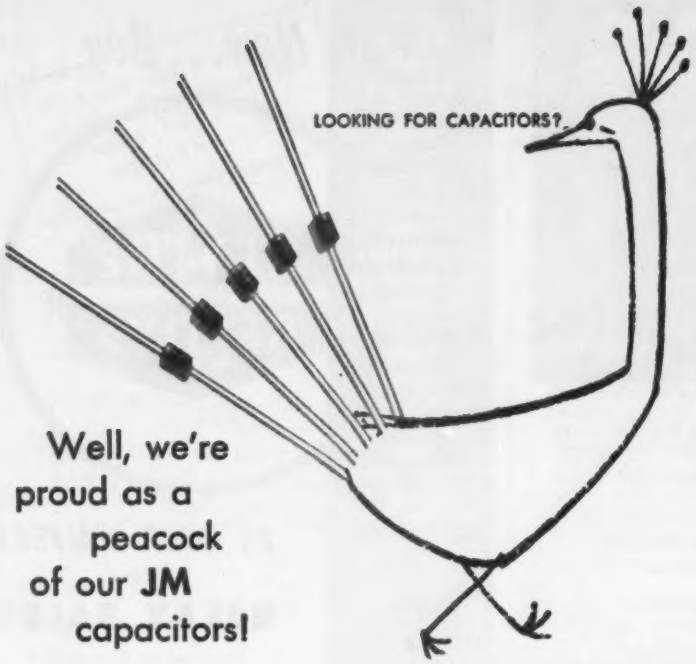


Well, we're proud as a peacock of our JM capacitors!

Choose from 49 EIA values. All have these characteristics:

Working voltage: 500 VDC

Insulation Resistance: 50,000 megohms minimum (500 VDC test)

Q Value: 100 minimum

Body Dimensions:

0.1 to 10.0 mmf .160 ± .005 dia. x .400 max. L

10.0 to 18.0 mmf .187 ± .005 dia. x .230 max. L

Leads:

No. 20 AWG Copper, heavily tinned to insure good solderability. 1⅛ ± ⅛ long

Tolerance Color Code:

Under 10.0 mmf	10.0 mmf and Over
20% None	20% Black
10% Silver	10% White
5% Gold	5% Green

Jeffers Fixed Composition JM Capacitors are ideal for a broad range of circuit applications. They offer operating stability, moderate Q—and those other two indispensable characteristics, dependability and economy! Use them as coupling capacitors between RF amplifiers, AVC circuits, oscillators, IF stages—and in many other circuits where low capacitance is a requirement.

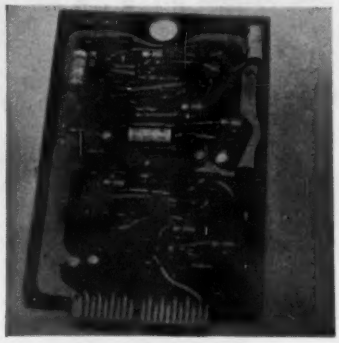
The insulated JM body consists of a molded thermosetting resin with a ceramic dielectric material dispersed throughout. The firmly embedded lead wires serve as electrodes.

For all the facts about the Jeffers line of JM Capacitors, write today!

JEFFERS ELECTRONICS DIVISION
Speer Carbon Company
Du Bois, Pennsylvania

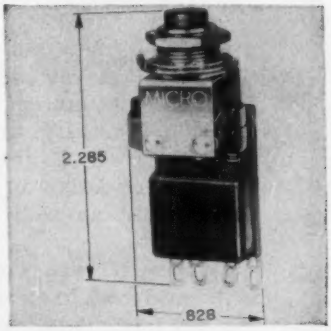
Capacitance in mmfd Standard Values in			Color Bands			Max. Body Length
20%	10%	5%	1st	2nd	3rd	
.10	.10		Brown	Black	Gray	.400
	.12		Brown	Red	Gray	.400
.15	.15		Brown	Green	Gray	.350
	.18		Brown	Gray	Gray	.281
		.20	Red	Black	Gray	.281
.22	.22	.22	Red	Red	Gray	.281
		.24	Red	Yellow	Gray	.281
	.27	.27	Red	Violet	Gray	.281
		.30	Orange	Black	Gray	.281
.33	.33	.33	Orange	Orange	Gray	.281
		.36	Orange	Blue	Gray	.281
	.39	.39	Orange	White	Gray	.281
		.43	Yellow	Orange	Gray	.281
.47	.47	.47	Yellow	Violet	Gray	.281
		.51	Green	Brown	Gray	.281
	.56	.56	Green	Blue	Gray	.281
		.62	Blue	Red	Gray	.281
.68	.68	.68	Blue	Gray	Gray	.281
		.75	Violet	Green	Gray	.281
	.82	.82	Gray	Red	Gray	.281
		.91	White	Brown	Gray	.281
1.0	1.0	1.0	Brown	Black	White	.281
	1.1		Brown	Brown	White	.281
	1.2	1.2	Brown	Red	White	.281
		1.3	Brown	Orange	White	.281
1.5	1.5	1.5	Brown	Green	White	.281
		1.6	Brown	Blue	White	.281
	1.8	1.8	Brown	Gray	White	.281
		2.0	Red	Black	White	.281
2.2	2.2	2.2	Red	Red	White	.230
		2.4	Red	Yellow	White	.230
	2.7	2.7	Red	Violet	White	.230
		3.0	Orange	Black	White	.230
3.3	3.3	3.3	Orange	Orange	White	.230
		3.6	Orange	Blue	White	.230
	3.9	3.9	Orange	White	White	.230
		4.3	Yellow	Orange	White	.230
4.7	4.7	4.7	Yellow	Violet	White	.230
		5.1	Green	Brown	White	.230
	5.6	5.6	Green	Blue	White	.230
		6.2	Blue	Red	White	.230
6.8	6.8	6.8	Blue	Gray	White	.230
		7.5	Violet	Green	White	.230
	8.2	8.2	Gray	Red	White	.230
		9.1	White	Brown	White	.230
10.	10.	10.	Brown	Black	Black	.230
	12.		Brown	Red	Black	.230
15.	15.		Brown	Green	Black	.230
	18.		Brown	Gray	Black	.230

series L, 25 chokes from 1.0 μh to 10,000 μh. Series S and M kits are priced at $15 each; series L kit, $20. **Circle 462 on Reader Service Card.**



Shift Registers compact units

DI/AN CONTROLS, INC., 40 Leon St., Boston, Mass., has available compact, transistor shift registers capable of operation with full reliability up to 2 mc (2,000,000 bits second) for use in shifting instrumentation, and control systems. Two standard models are in current production: The SR-4-2M, containing four register stages plus a shift-input amplifier; and the SR-10-2M containing ten register stages and a shift-input amplifier. **Circle 463 on Reader Service Card.**



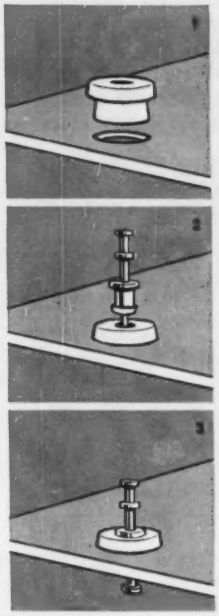
One-Shot Switches for high-speed use

MICRO SWITCH, Freeport, Ill. A new series of pushbutton switch assemblies—incorporating an electronic circuit to produce a single, microsecond-length pulse with each operation—has been introduced. Company says the unique capabilities of the 1PB600 series

USECO

Cut production costs, reduce inventory, lower terminal costs

with new LOC-FIT insulated & feed-thru TERMINALS



1. PUSH TEFLON GROMMET INTO HOLE—by hand or with available tooling. No precision tolerances, no counter-boring or de-burring operation needed with Loc-Fit terminals. SAVE 40% ON CHASSIS PREPARATION!

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TEST LOC-FIT YOURSELF! Request engineering Data Sheet and representative samples of Loc-Fit insulated and feed-thru terminals.

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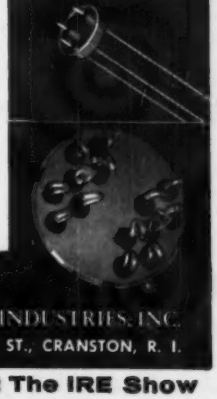

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Hickory Brand Coaxial Cables are especially adaptable to applications requiring high, very high and ultra-high frequencies.

The dielectric material of these RG/U Cables is polyethylene . . . shielding braid is single or double copper, single tinned copper or double silver as required.

Quality-engineered Hickory Brand Electronic Wires and Cables are precision-manufactured to meet the most exacting specifications.

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Write for complete information on the full line of

HICKORY BRAND Electronic Wires and Cables

Manufactured by

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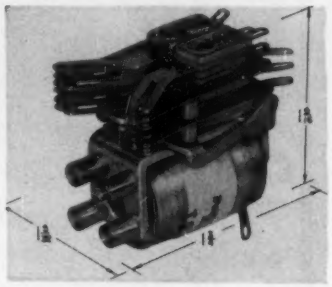
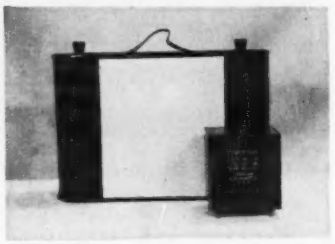
3605

of switches eliminate the need of designing special pulse input circuits for high-speed electronic switching devices. The square wave pulse width is factory adjustable from 0.2 to 2.5 μsec, and the amplitude from 3 to 60 v. Contact arrangement is spdt. **Circle 464 on Reader Service Card.**



Short Coil Relay long operating life

POTTER & BRUMFIELD, INC., Princeton, Ind., is introducing a modified version of its short coil TS telephone type relay that will feature bifurcated contact arms with as many as twenty arms per relay (ten arms per stack). The TS operates on as little as 100 mw per movable arm and can be furnished to operate on voltages up to 110 v d-c. It will switch up to 4 amperes at 115 v, 60 cps, resistive loads. **Circle 465 on Reader Service Card.**



Power Supply replaces B battery

FERROTRAN ELECTRONICS CO., INC., 693 Broadway, New York 12, N. Y., has developed a new line of semiconductor devices (Powertrans) which from an output voltage point of view are exact replacements for B batteries. They operate from a-c line voltage to give a source of regulated, ripple-free, ungrounded d-c voltage. A typical unit measures 3

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Only COLOR-LITES permit the design of compact, low cost panels. Their small size and clean, neat appearance assist in the design of more functional indicator panels for test equipment, production machinery, missile test stands and aircraft.

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Color-Lite

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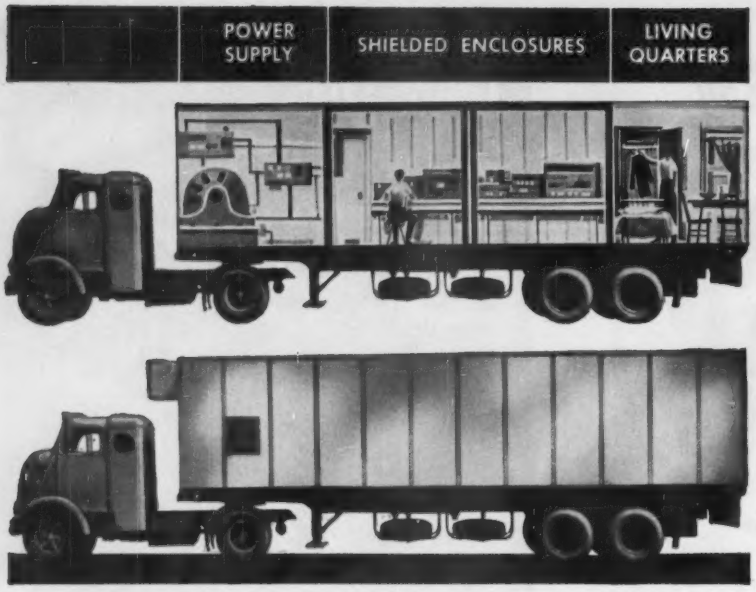

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custom designed for on-the-spot interference testing

Now you can get the reliability and the outstanding performance of ACE Shielded Enclosures on wheels! . . . complete with self-contained power source and living accommodations . . . custom designed to your specific requirements.

1. **ACE SHIELDED TRAILERS & TRUCKS**
   Fabricated to ACE's patented RFI* design, using one, two or three shields, these enclosures provide over 100 db attenuation at all frequencies from 15 kc through 1,000 mc and will closely approximate 100 db at 10,000 mc . . . exceeding the attenuation requirements of MIL-E-4957A (ASG). Provisions can be made for mounting antennas, shock-mounting test equipment, installing intercom systems and coaxial connector panels.
2. **SELF-CONTAINED POWER SUPPLY**
   The mobile unit can be equipped with a power control panel and a diesel driven generator. having outputs up to 20 kw. External power connections can also be furnished.
3. **LIVING QUARTERS**
   Complete living quarters having all the facilities necessary for the comfort of operating personnel can be furnished. The entire trailer can be air conditioned or heated.

ACE handles the entire mobile shielded enclosure package — from the wheels on up. Every detail is carefully engineered to give the highest attenuation and the most efficient performance. The trailer is designed to meet the legal specifications of all states. Write to ACE outlining your mobile shielded requirements. Be sure to request a copy of ACE's standard enclosure catalog.

*Lindsay Structure

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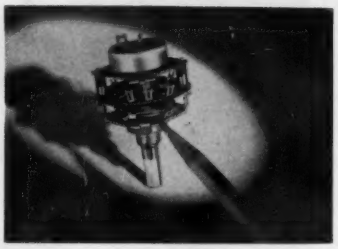
by 2½ by $3\frac{3}{16}$ in. ($\frac{1}{4}$ the size of a B battery) and can supply three different voltages—45 v, 67½ v, and 90 v. Each voltage is regulated and can supply a minimum of 40 ma to a load. **Circle 466 on Reader Service Card.**



Spring Return Switch
simple construction

CENTRALAB, a Division of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc. In the construction of the new PA-070, a steel alloy spring is built into the index mechanism of the switch and controls the spring return action. This results in simple and economical construction. Switches with this spring return feature can be supplied as single or double section units, or as single section units with line switch. Up to 6 positions per section, including the spring return position, are available. **Circle 467 on Reader Service Card.**

Waveguide Switch
microminiature

DON-LAN ELECTRONICS, INC., 1101 Olympic Blvd., Santa Monica, Calif., has developed the Delta microminiature waveguide switch. Weight is 0.37 lb. Designed for the X band—812 to 12.0 kmc—it is remotely controlled to provide a highly reliable

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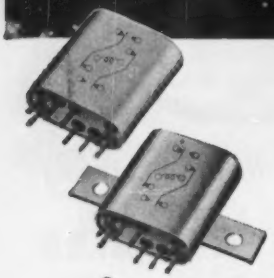
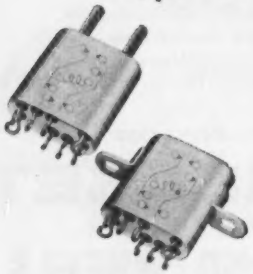
CIRCLE 259 READERS SERVICE CARD

crystal can size relays by ADVANCE





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offered in 3 terminal arrangements...6 mounting arrangements, and 7 resistance values (30 to 10,000 ohms).
—AVAILABLE AT ADVANCE DISTRIBUTORS

—these construction features assure exceptional reliability:

Positive sealing. Advance's use of induction heating cuts rejects from faulty soldering to a negligible figure. Soldering is accomplished at high speed, hence damage to the relay due to heat transfer is eliminated.

RADIFLO testing for leakage is used to detect leaks as small as 10^{-8} cc/sec. All relays that pass this test will function after long shelf life.

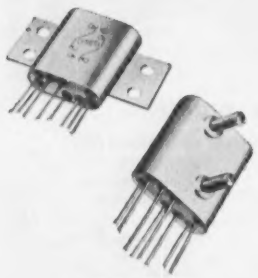
RIQAP* program approval. Under RIQAP, the Signal Corps constantly checks Advance's quality control and inspection, to insure military standards of reliability for all Advance customers, both military and industrial.

*Reduced Inspection Quality Assurance Plan of the U.S. Army Signal Corps.

SPECIFICATIONS

Coil resistance:	Available in 7 values, from 30 to 10,000 ohms.
Shock:	50 G's for 11 milliseconds.
Vibration:	10 to 34 cycles per second at maximum excursions of .4". 34 to 2000 cps 20 G's acceleration.
Operating power:	Pull in power 250 milliwatts at 25°C.
Contact rating:	2 amps resistive at 32 VDC or 115 VAC.
Life:	100,000 operations minimum at rated current.
Weight:	0.45 ounce.
Size:	7/8" high x 51/64" wide x 23/64" deep.

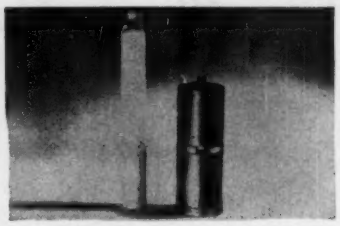
Our Applications Engineering Dept. will be pleased to work with you on your special application problems.



ADVANCE RELAYS

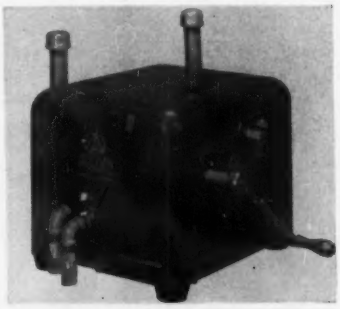
ADVANCE RELAYS
ELGIN
A PRODUCT OF ELECTRONICS DIVISION
ELGIN NATIONAL WATCH COMPANY
2435 N. NAOMI ST., BURBANK, CALIFORNIA

means of switching a single waveguide input to either of two outputs. It features a switching time of only 0.007 sec and isolation of 50 db down minimum. **Circle 468 on Reader Service Card.**



Inertia Switches normally closed

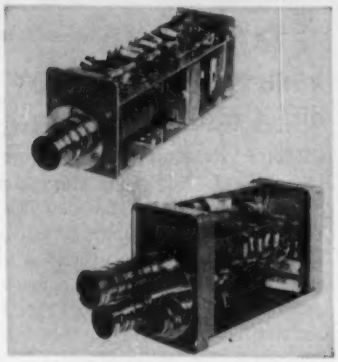
INERTIA SWITCH, Division of Safe Lighting, Inc., 527 Lexington Ave., New York 17, N. Y., has available spdt or sptt miniature inertia switches actuated by acceleration, deceleration, impact, and/or shock. Acceleration sensitivity can be adjusted from less than 1 g to over 100 g's with an accuracy of 1 percent. Constant performance is maintained over −65 F to 250 F. Response time (to open) is less than 1 millisec. **Circle 469 on Reader Service Card.**



Resin Dispenser variable ratio

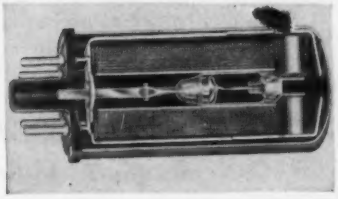
DELSEN CORP., 719 West Broadway, Glendale 4, Calif., announces a new variable ratio resin dispenser for use with most two component liquid resin and hardener systems. By means of a simple lever adjustment, the ratio of resin to hardener may be varied over a wide range. Use of the unit allows rapid changeover from one resin-hardener system to another. Changes in resin to hardener ratio can readily be made in

order to compensate for changes in ambient temperature. A reference scale is provided so that ratios may be accurately reset. **Circle 470 on Reader Service Card.**



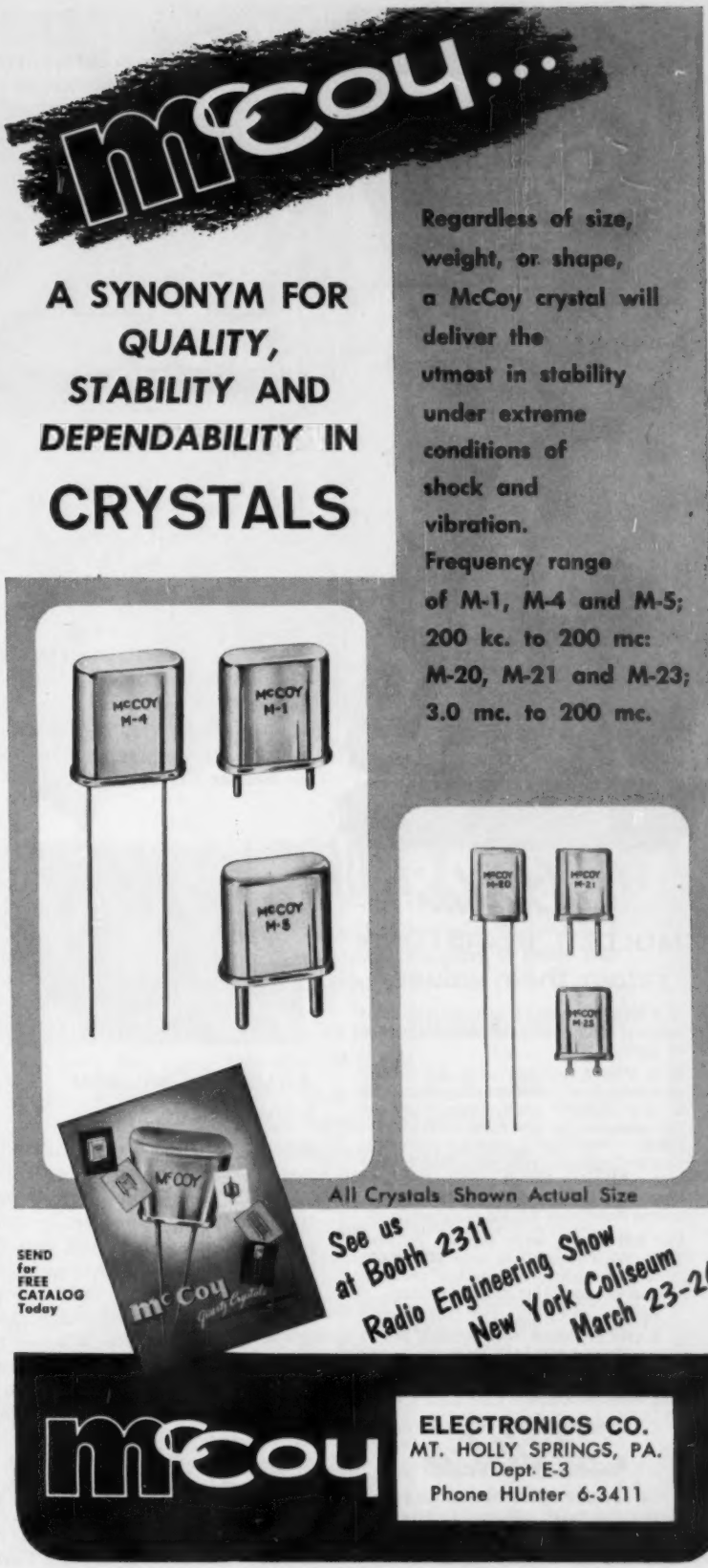
C-C TV Camera ruggedized

ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J., has developed a ruggedized closed-circuit tv camera to withstand extremely high acoustic noise, shock, vibration or even an explosion. It is ideal for installations on test stands for rockets, jets, or internal combustion engines, missile launching areas, wind tunnels, gun firing areas, and steam turbine test cells. The camera, available either as a transistor type (TC-200-RT) or with subminiature tubes (TC-200-RS), is designed in adherence to the company's building-block technique. **Circle 471 on Reader Service Card.**



Sensitive Relay high-speed

C. P. CLARE & Co., 3101 Pratt Blvd., Chicago 45, Ill. Type HGS mercury-wetted contact relay is biased with permanent magnets which are adjustable for single-side stable or bi-stable operation. Operating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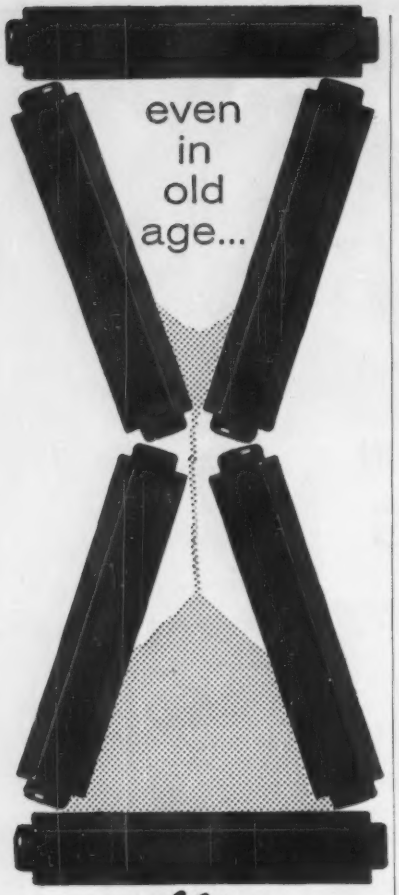

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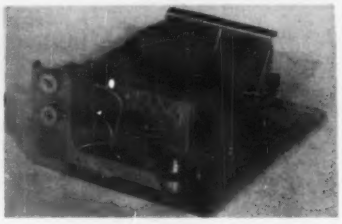
1839 West Pico Blvd., Los Angeles 6, Calif.
CIRCLE 262 READERS SERVICE CARD

speeds may be up to 200 cps or more. Sensitivity may be as low as ±2.5 mw for a bi-stable adjustment; as low as 5 mw for a single-side-stable adjustment. Contact rating is 2 amperes, 500 v, with a limit of 100 va. **Circle 472 on Reader Service Card.**

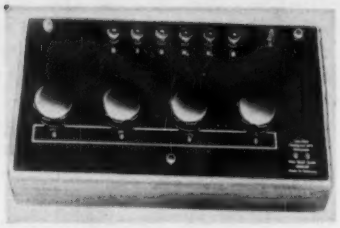
Liquid Vinyl in kit form

SPECTRA-STRIP WIRE & CABLE CORP., Box 415, Garden Grove, Calif., announces a new deal for Vyna-Kote, liquid vinyl. This handy material for the repair of all kinds of damage to vinyl insulated wires is now being offered in kit form. The kit consists of twelve 2-oz bottles, two each of 10 colors, 1 clear and 1 thinner, all arranged on a finished hardwood stand. **Circle 473 on Reader Service Card.**



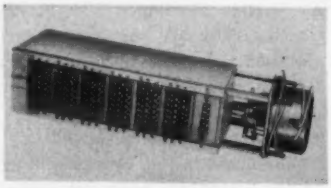
Airspeed Computer transistorized

MINNEAPOLIS-HONEYWELL REGULATOR CO., 2600 Ridway Road, Minneapolis 13, Minn. A new light-weight true airspeed computer is completely transistorized and requires only 10 w of power. The computer is for use in aircraft and missiles when critical air speed computation is not available through a central air data computer. The HG45 has a range up to 750 knots and 55,000 ft altitude at −65 to 170 F. It was designed—depending on the flight envelope—to hold an accuracy of 1 percent or less. Weight of the computer with shock mounts is 4.2 lb, and size is less than 0.2 cu ft. **Circle 474 on Reader Service Card.**



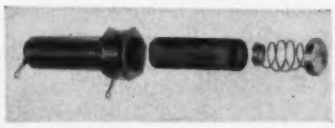
Ratio Set direct reading

PHYSICS RESEARCH LABORATORIES, INC., P. O. Box 555, Hempstead, N. Y., announces the new Otto-Wolff 4-dial direct reading ratio set. This ratio set with a precision of 1 ppm is said to afford the easiest, quickest and most precise method of comparing high precision resistors against known standards. It is encased in a polished mahogany box with removable cover. **Circle 475 on Reader Service Card.**



Rotary Switch solenoid-operated

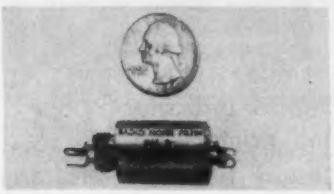
THE DAVEN CO., Livingston, N. J., has available a new type solenoid-operated unidirectional rotary switch, Spec. No. 6634. Consisting of six poles with 24 nonshorting positions per pole, the new unit can be operated at temperatures up to 125 C and at altitudes up to 80,000 ft. It will withstand an acceleration of 50 g. The switch measures 2¾ in. sq by 9 in. in overall depth, including the solenoid. **Circle 476 on Reader Service Card.**



Battery Holder compact design

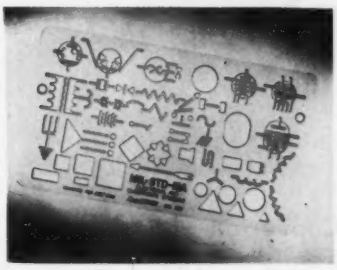
SECURITY DEVICES LABORATORY, Rochester 21, N. Y. The BH300

series transistor battery holder accommodates batteries and cells up to 11/16 in. diameter with lengths of from 1 19/64 in. to 5 55/64 in. which makes possible the use of different combinations of battery cells to provide for a wide selection of voltages. Its compact design provides for easy mounting through a ⅜ in. diameter hole in insulated or metallic panels up to ⅛ in. thick. **Circle 477 on Reader Service Card.**



R-I Filter subminiature

DOUBLE E PRODUCTS, 208 Standard St., El Segundo, Calif. Model 5833 subminiature radio interference filter features a 9/16 in. diameter case by 1⅜ in. long. It is rated at up to 2 amperes at 28 v d-c to 105 C, and will filter most d-c motors to the requirements of MIL-1-6181B. Unit has a 5/16-24 threaded mounting bushing and may be screwed into a panel or held in place with a nut and lockwasher. **Circle 478 on Reader Service Card.**



Symbols Template 7 in. by 4 in. overall

RAPIDESIGN, INC., P. O. Box 429, Burbank, Calif. The No. 314 MIL-STD-15A symbols template is made of 0.040 mathematical quality plastic and designed for 0.200 in. grid paper. It is precision milled with bevel cut to facilitate smooth depiction of latest symbols embodied in government drafting require-

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Higher Speed... Greater Accuracy?

achieve **both** with the

MEC Model 3010 X-Y Recorder

The MEC Model 3010 plots four variables in 2-color ink trace on a 30" x 30" surface. It maintains an overall **accuracy of better than .05%**, and is capable of the following performance characteristics:

- **Acceleration: Vertical—1,500 in/sec²; Horizontal—500 in/sec²**
- **Slew Speed: Each axis — 50 in/sec**
- **Pen Actuating Speed: Up to 100 marks per second**
- **Function Interchange: Automatic, all electronic**
- **DC Amplifiers: Self-Contained, Contact Stabilized, for Reference, Scale Factor and Parallax Circuits**
- **Plug-In Modules: Customized to afford maximum adaptability to individual customer requirements.**
- **Paper: Held in place by vacuum system.**

In addition, MEC manufactures a number of items which further increase the utility and convenience of the Model 3010. These include electronically actuated symbol markers; automatic plot fold capability, voltage comparator units, etc.

For specifications and further information on the Model 3010 Recorder, write to:

MEC

MILGO ELECTRONIC CORP.

7601 N. W. 37th AVENUE, MIAMI 47, FLORIDA

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AUTOGRAF
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X - Y - (T)* RECORDER

A direct writing, low frequency oscillograph for:

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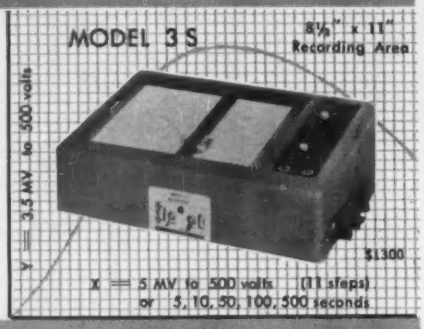
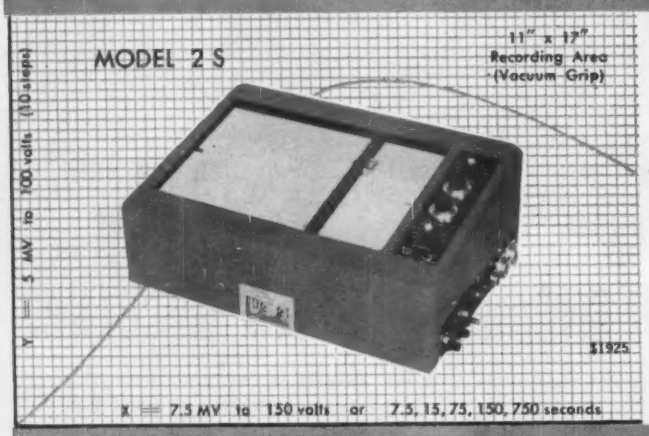
- PLOTTING ONE VARIABLE VS TIME

With appropriate accessories will:

- PLOT IDENTIFIED POINTS FROM TAPE OR CARDS
- READ OUT CONDUCTING CURVES
- AUTOMATICALLY PRODUCE GAIN-FREQUENCY RECORDS




MODEL 2 S
11" x 17" Recording Area (Vacuum Grip)
* with TIME BASE
Y = 5 MV to 100 volts (10 steps)
$1925
X = 7.5 MV to 150 volts or 7.5, 15, 75, 150, 750 seconds

All models illustrated feature:

- Isolated servo-actuated drives for each axis
- Full range zero set and zero suppression
- Input filters and stepless range controls
- 200,000 ohms/volt input resistance
- One second or less for full scale deflection
- Better than 0.25% accuracy with 0.1% resetability

MODEL 6 S
AUTOMATIC FRAME ADVANCE
10" x 10" Recording Area (Vacuum Grip)
Y = 5 MV to 100 volts (10 steps) or 5, 10, 50, 100, 500 seconds
$2750
X = 5 MV to 100 volts (10 steps)

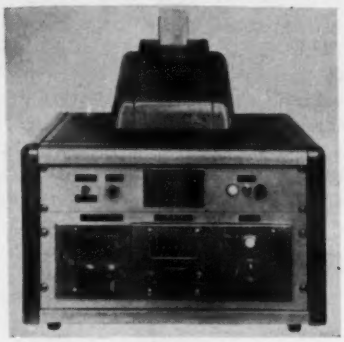
All prices f.o.b. factory. Prices and specifications subject to change without notice.

Call our sales representative in your area or write direct for additional information.

F. L. MOSELEY CO.

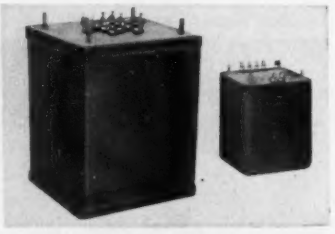
409 N. FAIR OAKS AVE., PASADENA, CALIFORNIA

ments for components. Price is $4.00. **Circle 479 on Reader Service Card.**



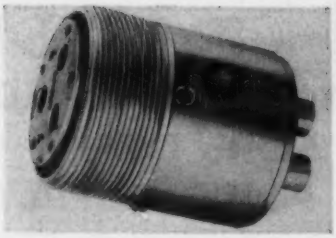
Digital Indicator and printer

GILMORE INDUSTRIES, INC., 13015 Woodland Ave., Cleveland 20, Ohio. Model 176 digital indicator and printer is designed for high accuracy and resolution indication. It permanently records weight, strain, temperature, pressure, and other variables which can be measured by sensitive bridge-type transducers. Unit gives continuous monitoring and permanent periodic recording of the variable (in printed tape form for later analysis) at rates up to two readings per sec. Controls are provided for run and calibration selection. **Circle 480 on Reader Service Card.**



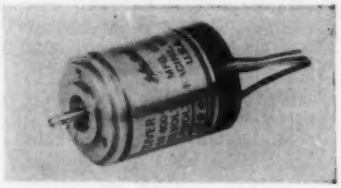
Converters transistor type

FREED TRANSFORMER CO., INC., 1788 Weirfield St., Brooklyn 27, N. Y., has available a line of reliable, highly efficient static d-c to d-c transistor converters. They are rugged and maintenance free, and feature high power to weight ratio, arc-free operation and long life service. All models are enclosed in hermetically sealed cans. **Circle 481 on Reader Service Card.**



Connectors
pin or socket

CONNECTOR SEALS CORP., Rosemead, Calif., announces its SEAL-E connector in either pin or socket type, in sizes up to and through size O. It offers the combined advantages of internal connector moisture-proofing by interfacial sealing of mated MS-E type connectors, plus partitive hermetic sealing of application units as created by glass seals. **Circle 482 on Reader Service Card.**



Synchro-Receiver
precision unit

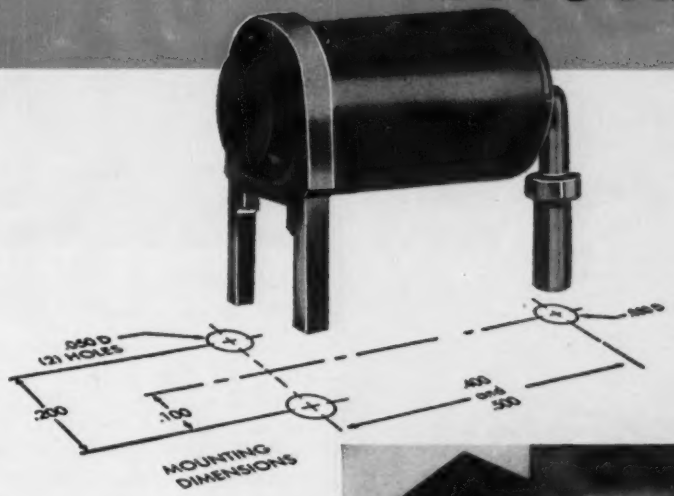
JOHN OSTER MFG. CO., 1 Main St., Racine, Wisc., offers a new size 10 precision synchro-receiver which meets MIL-I-7057 and is designed for indicator applications. Type 10-4085-19 has −55 C to +71 C ambient temperature range, 1 deg dynamic test accuracy and 5 sec damping. Internal damping is by rotor bar technique. Torque gradient is 2,200 mg mm per deg, phase shift (R to S) 4.5 deg. **Circle 483 on Reader Service Card.**

Transformers
double slug

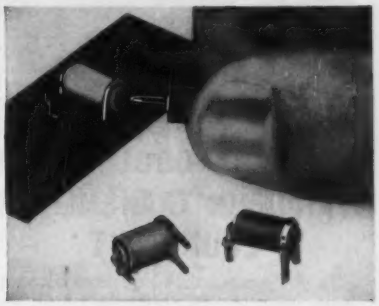
MAURY & ASSOCIATES, 10373 Mills Ave., Pomona, Calif., introduces its

Another Sealectro First!

PRINTED WIRING JACK



Yes, another Sealectro "First"! Here's a flat-mount subminiature jack (SKT-PC Series) for printed-wiring boards. Mounts in three holes forming a triangle. Takes standard .080" probe or matching plug. Simply dip-soldered from under side of board for rugged mechanical and electrical installation.

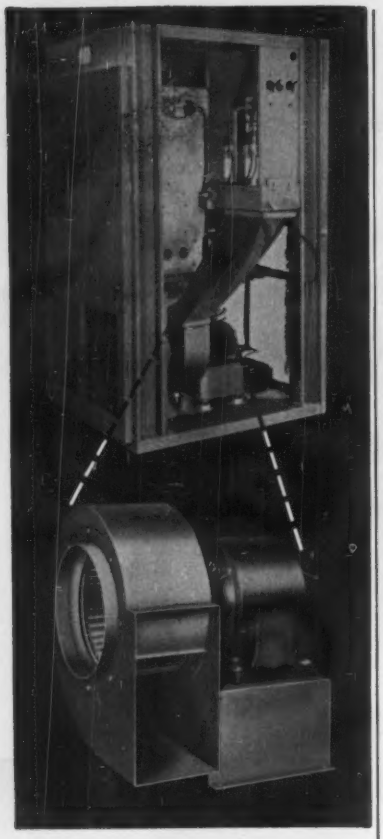


- ★ Mounts flat on top side of printed-wiring board.
- ★ For dip soldering in grid coordinate spacings.
- ★ Matching subminiature plug available.
- ★ Long-life contacts of heat-treated Beryllium copper.
- ★ In ten different code colors.
- ★ Takes standard .080" probe or matching plug. Teflon*-centered entry relieves contacts from mechanical strain.

New Manual containing the up-to-date listings of hundreds of "Press-Fit" terminals, jacks and plugs, sent on request.

*Reg. Trademark of E. I. DuPont de Nemours & Co., Inc.

Sealectro CORPORATION
610 Fayette Avenue, Mamaroneck, N. Y.



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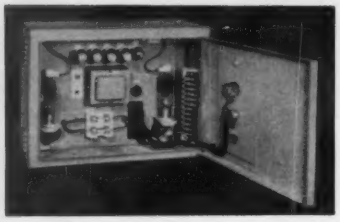
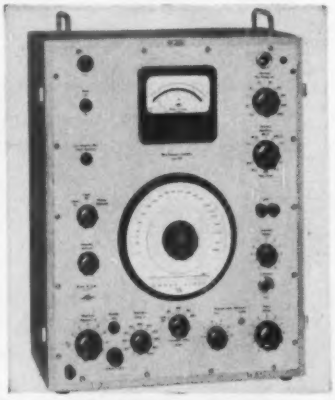
precision, coaxial, double slug transformers for matching impedances where extreme accuracy of vswr measurements are required. The instruments are designed to match vswr as high as 4:1 at the design center frequency and will also match small reactive vswr within ± 500 mc of the design center frequency. **Circle 484 on Reader Service Card.**



Electronic Control for bench welders

ROBOTRON CORP., 21300 W. Eight Mile Road, Detroit 19, Mich. Model 10E49E-A controls the weld current of all types of resistance bench welders and is especially suited for resistance welding of small delicate parts. It is available for 115/230 v range and is equipped with two plug-in thyratron firing tubes. The thyratron contactor is rated at 12 amperes at 50 percent duty cycle with a 5-sec averaging time. **Circle 485 on Reader Service Card.**

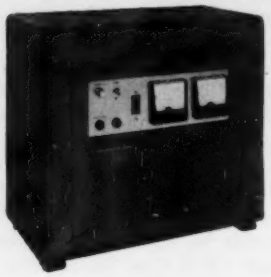


Signal Generator and control system

B & K INSTRUMENTS, INC., 3044 W. 106th St., Cleveland, Ohio, has announced a new signal generator and control system. The instrument is designed for use with graphic read-

EIC TYPE BE-1

TRANSISTORIZED AC to DC POWER SUPPLY



A solid-state, 12-volt, regulated dc power supply, the Electrodynamic Instrument Corporation BE-1 will supply up to 50a at 12½ vdc from a 115 vac, 60 cps source, with a regulation of better than 0.1% from 0-50a.

The low output impedance (0.001 ohm dc to 1 KC) and low ripple (less than 1 millivolt at any load) make the BE-1 ideal for replacing storage batteries for testing equipment where a commercial ac source is available. The power supply will provide an instantaneous surge current of 100a for operating non-linear resistance loads.

There are design provisions for remote sensing at the load to eliminate the effect of voltage drops in the output leads. A direct short on the output terminals cannot damage the unit.

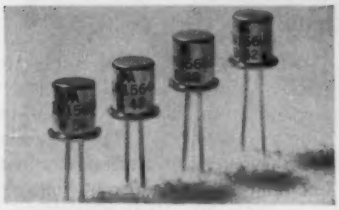
For bench testing, the BE-1 power supply will mount in a standard 19 in. rack or custom cabinet.

ELECTRODYNAMIC INSTRUMENT CORPORATION

2508 Tangley Road
Houston 5, Texas

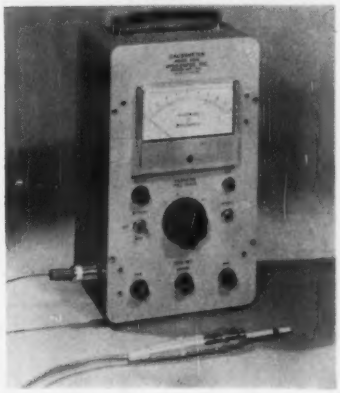
CIRCLE 267 READERS SERVICE CARD

out in automatic frequency response measurements over the 200 cps to 200 kc range. Unit features a control circuit, the principle of which is overall system feedback. **Circle 486 on Reader Service Card.**



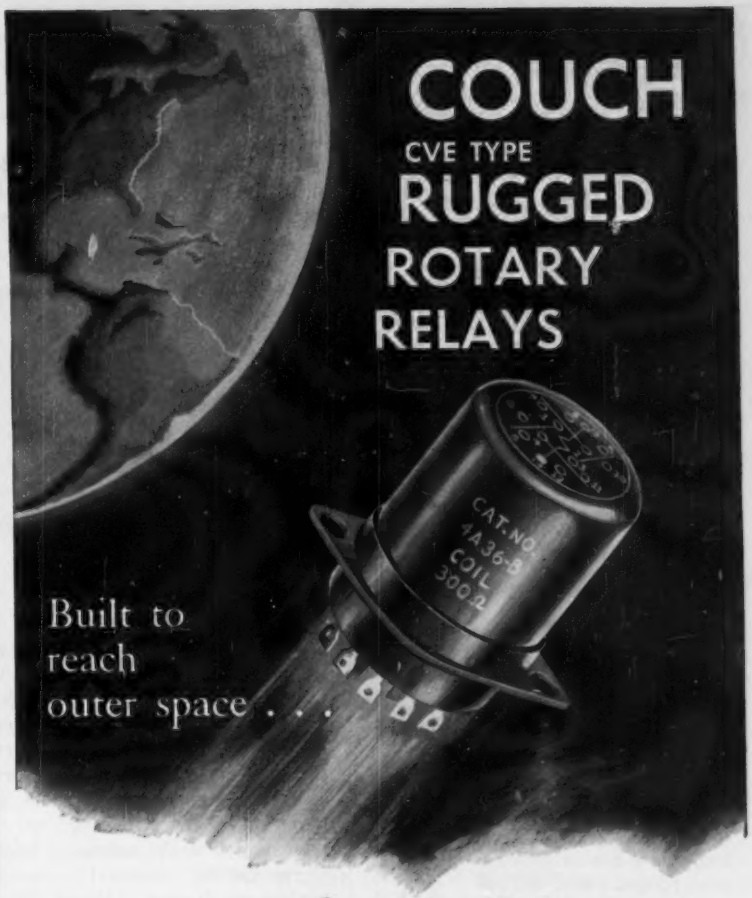
Silicon Rectifiers diffused-junction

MOTOROLA, INC., 5005 E. McDowell Road, Phoenix, Ariz. Types 1N-1563A through 1N1566A silicon rectifiers offer peak inverse voltages of 100 through 400. One cycle average reverse current is limited to 150 μa maximum when rectified output is 250 ma and ambient temperature is 150 C. Forward rectified currents are 1.5 amperes and 250 ma at 25 C and 150 C ambient temperatures. **Circle 487 on Reader Service Card.**



Gaussmeter for field and lab

DYNA-EMPIRE, INC., 1075 Stewart Ave., Garden City, N. Y. Completely transistorized and modified to operate on either 105-125 v power supply or on internal batteries, the model D-855 gaussmeter is designed for accurate measurement of flux fields up to 30,000 gauss. It gives accurate flux density measurement and determines flow direction,



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Couch Rugged Rotary Relays were used in the Atlas 10B satellite launched from Cape Canaveral on December 18, 1958.

Couch relays were selected by Convair Astronautics because of their proven ability to perform in the most severe environments. Modern quality control techniques coupled with a simple rugged design provide the reliability needed for missiles.

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is ideal for locating and measuring stray fields, plotting variations in strength and checking production lots against a standard. It gives no ballistic reading . . . requires no jerk or pull. It can be equipped to measure earth's field flux density. **Circle 488 on Reader Service Card.**

Connectors multiple-contact

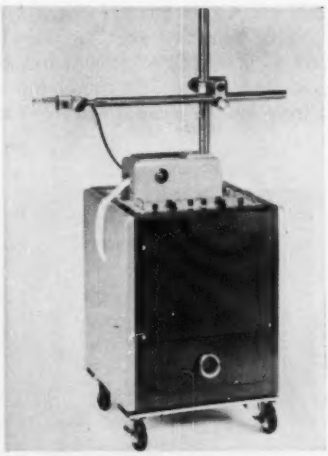
U. S. COMPONENTS, INC., 454 E. 148 St., New York 55, N. Y., announces miniature bracket-type screw lock connectors with the exclusive Floating Body Isolation. In patent terms this means ". . . when connector is coupled, stresses and strains are taken up by the frame and are not transmitted to the connector bodies of insulating material supported within the frames." **Circle 489 on Reader Service Card.**

Filament Supply plug-in unit

C. J. APPLEGATE & CO., 1840 24th St., Boulder, Col. Model 227 28-v d-c filament supply is similar to the other Uniplug low voltage supplies except for the higher output voltage at 1.2 amperes maximum. Ripple voltage is 2 percent at maximum output, and proportionately less at lower output currents. Input is 117 v a-c 60 cps. The transformer has five input taps to adjust to line and load conditions. Unit measures 3½ by 3¾ by 4½ in. overall seated. **Circle 490 on Reader Service Card.**

Power Inverter transistorized

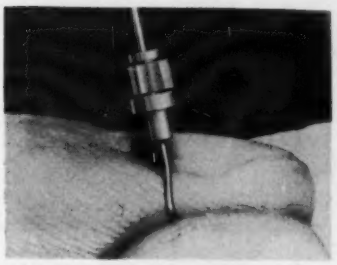
POWER SOURCES, INC., Burlington, Mass. A transistorized inverter operating from any d-c source to provide sinusoidal a-c, the Sineverter offers clean sine-wave power without bulky filtering. Input voltage is up to 50 v d-c, and output voltage can be obtained as desired with a frequency from 50 to 1,500 cps. Total harmonic content is normally less than 5 percent and can be specified to 1 percent if desired. Unit is both open- and short-circuit stable. **Circle 491 on Reader Service Card.**



Tension Analyzer for wire checking

BRUSH INSTRUMENTS, 37th and Perkins Ave., Cleveland 14, Ohio. All types of wire may be checked for tension variations during coil winding with the model BL-825 tension analyzer. It aids the manufacturer in producing uniform wire coils at optimum high winding speeds by recording both the static tension level and dynamic tension variations. Proper control of high winding speeds can reduce the overstretching of wire; thus eliminating overheating of the coil, variations

in resistance, and breakdown of insulation. **Circle 492 on Reader Service Card.**

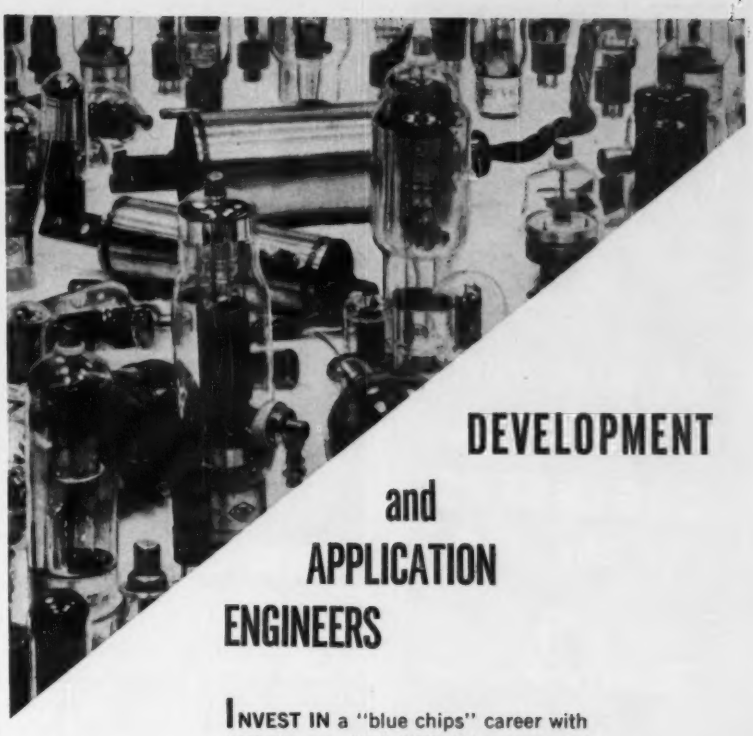


Component Socket for p-c boards

GRINNELL-HARRIS ELECTRONICS, INC., 4130 Temple City Blvd., Rosemead, Calif. The dual-entry Vari-Grip socket features a crimped snap-lock feed-through design that eliminates solder installations for testing expensive component parts, saving both circuit boards and components, and decreasing labor costs. Finished in gold-flashed copper alloy, the sockets are easily crimped in place for positive high-speed assembly. A beryllium-copper spring band is used to snap-lock the wire after insertion during circuit board build-up. **Circle 493 on Reader Service Card.**

Milliohmmeter low range

KEITHLEY INSTRUMENTS, INC., 12415 Euclid Ave., Cleveland 6, Ohio. Portable and battery-powered, the model 502 milliohmmeter is a fast and accurate instrument which measures down to 30 micro-ohms. Typical uses include measurements



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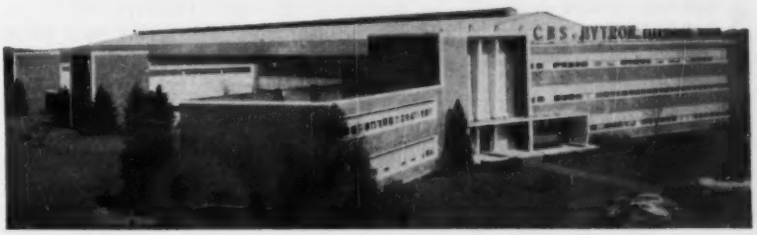

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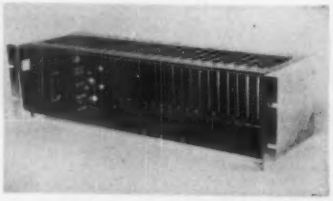
of conductivity in semiconductors, liquids and corrosion; and testing of printed circuits, waveguides and grounding systems. The instrument applies only 2 μw across the test circuit, thus providing safety and reliability for checking squibs, carbon bridges and similar explosive devices. **Circle 494 on Reader Service Card.**

Radar System Tester
portable unit

GENERAL MILLS, INC., 1620 Central Ave., Minneapolis 13, Minn., has developed the AN/GPM-25 radar system tester. This light-weight portable unit provides convenient, rapid, comprehensive testing and evaluation of the operational capabilities of aircraft radar systems. Designed originally for use in testing bombing radar systems, it performs equally well as a navigation and weather radar tester. **Circle 495 on Reader Service Card.**



Card File
for computer elements

RANSOM RESEARCH, 323 W. Seventh St., San Pedro, Calif. A new plated steel card file assembly, designed to accommodate up to 24 printed circuit card-type 4½ by 5 in. computer elements, requires only 5¼ in. of standard 19-in. relay rack panel space and has a depth of only 7 in. Plastic sliders are provided for guiding the p-c cards (computer elements) to the connector and to provide lateral support against vibration and shock. **Circle 496 on Reader Service Card.**

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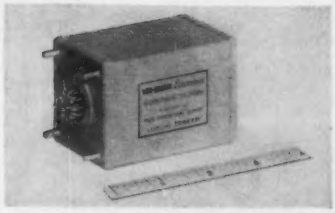
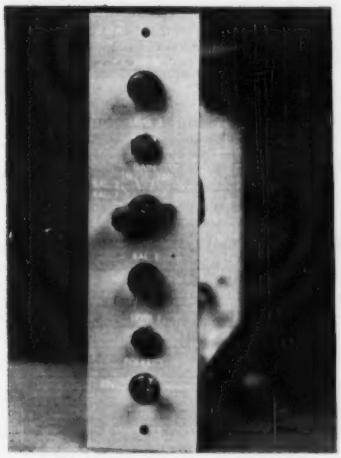


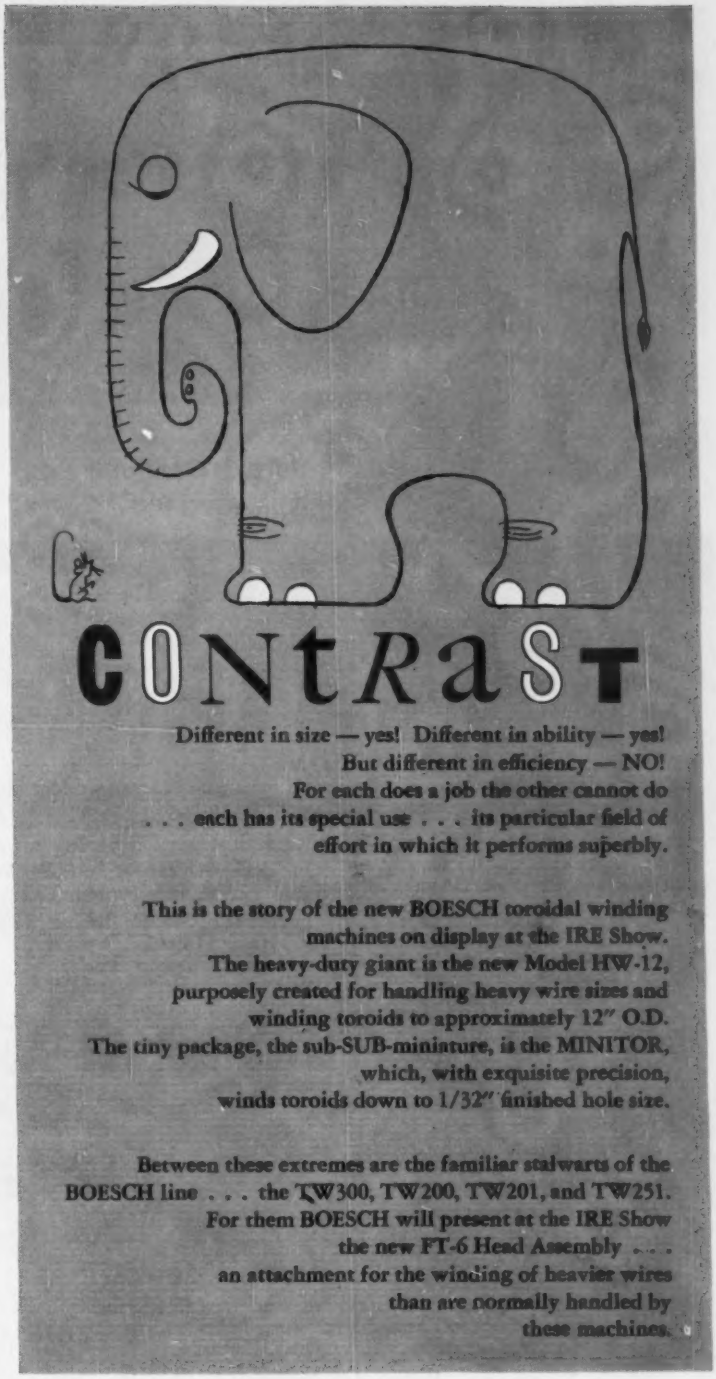
Time Delay Relays highly reliable

VOI-SHAN ELECTRONICS, 13259 Sherman Way, North Hollywood, Calif., announces new electronic time delay relays that are built to meet military specifications for use in aircraft, missiles and ground support equipment. Operating scope of the new units is so broad—from 60 millisec to 600 sec—that they could serve to program an entire ground checkout procedure or control the better part of a missile flight. Overall size is 2 in. by 2 in. by 3 in. Total weight is 15 oz. Units are available with one to six-pole load switches. Durability specifications call for a minimum of 100,000 trouble free operations, even under adverse conditions. **Circle 497 on Reader Service Card.**



D-C Amplifier transistorized

ENSCO, INC., 3100 Eldredge St., Salt Lake City 15, Utah. Model DCA-2 is a high gain all-transistor, general purpose d-c amplifier, specially well suited for the medical field. It has pushpull input with a high common mode rejection. The output can be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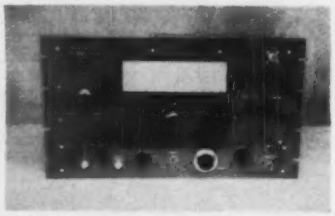
either pushpull or single ended. The Ensco preamplifier has a wide bandwidth, flat from 0 to 8 kc, down 3 db at 10 kc. The low noise and drift in the unit make it well adapted for low level amplification. **Circle 498 on Reader Service Card.**



Pulsed Oscillator high powered

ARENBERG ULTRASONIC LABORATORY, INC., 94 Green St., Jamaica Plain 30, Mass., announces the PG-650-C high powered pulsed oscillator. Major feature of interest is a Helipot delay potentiometer for covering three overlapping ranges to 200, 1,100, 11,000 μsec and a separate delayed trigger output for synchronizing any standard c-r oscilloscope with a delayed and expanded sweep, when operating the unit on internal trigger. A gating pulse coincident with the r-f output is available for blanking or intensifying purposes. **Circle 499 on Reader Service Card.**

Molding Powder many applications

HOUGHTON LABORATORIES, INC., Olean, N. Y. Hysol 8610 epoxy molding powder offers long storage stability, low shrinkage on cure, excellent electricals at elevated temperatures and good dimensional stability. Among many potential applications it is recommended for coil and resistor bobbins, shells for electrical components, relay assem-

Clean precision parts more safely

New Freon* solvents by Du Pont minimize cleaning hazards

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- **Leaves no residue**—"Freon" solvents evaporate completely, leave no deposit.

New "Freon" solvents by Du Pont degrease sensitive mechanical and electronic assemblies without damage to delicate parts. Since no inhibitors are needed, no residue is left on the parts, and "Freon" solvents can be recovered and reused without reinhibiting. Write for free "Freon" solvents booklet. E. I. du Pont de Nemours & Co. (Inc.), "Freon" Products Division 523, Wilmington 98, Delaware.

**Freon is Du Pont's registered trademark for its fluorinated hydrocarbon solvents.*

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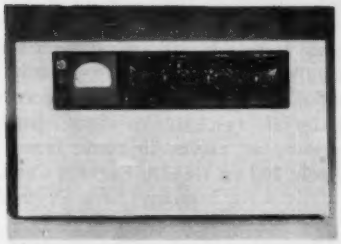
blies, connector plugs, and switch gear. **Circle 500 on Reader Service Card.**

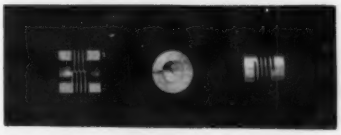


Limiting Amplifier very low distortion

FAIRCHILD RECORDING EQUIPMENT CORP., 10-40 45th Ave., Long Island City 1, N. Y., has developed the model 660 limiting amplifier for use in recording studios and broadcasting stations. Designed specifically to overcome many of the common problems encountered in automatically controlling program level, the model 660 has extremely fast attack time to catch short transients without audible or observable thumps. **Circle 501 on Reader Service Card.**

Plastic Capacitor high reliability

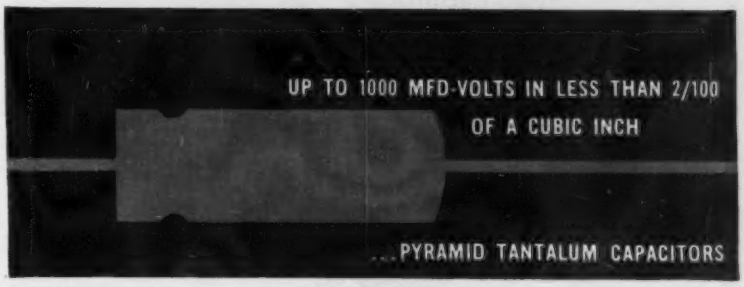
DIAMOND ELECTRONIC CORP., 64 White St., New York 3, N. Y. Type KYA capacitor is a hermetic bathtub enclosure of rugged construction. Temperature coefficient is zero ±10 ppm/deg C uniform from −55 C to +85 C; capacitance range, 0.01 to 1.0 μf; voltage to 1,000 vdcw; stability, ±0.05 percent long term; power factor, less than 0.1 percent at 25 C. **Circle 502 on Reader Service Card.**



Shaft-Couplings miniaturized

HELICAL PRODUCTS CO., 1402 The Strand, Hermosa Beach, Calif. A new line of shaft-couplings feature small size (¾ in. diameter by ¾ in. long, for ⅛ in. shaft) and light

When Top Quality Capacitors Are Required Specify Pyramid Mylar® or Tantalum



Miniaturized to provide maximum space economy.

New Pyramid Tantalum slug capacitors have cylindrical cases and contain a non-corrosive electrolyte. Due to the special construction of materials used in the manufacture of Pyramid Tantalum slug capacitors, these units are both seep and vibration proof. In addition, this type of capacitor assures long service life and corrosion resistance—made to meet MIL-C-3965 Specifications.

Commercially available immediately, these new Pyramid Tantalum capacitor units have an operating range between —55° C to 100° C for most units without any de-rating at the higher temperature.

Pyramid new Mylar capacitors have extremely high insulation resistance, high dielectric strength and resistance to moisture penetration.

Commercially available immediately, Pyramid Mylar capacitors have an operating range between —30° C to + 125° C with voltage de-ratings above +85° C. Pyramid wrapped Mylar capacitors—Series Nos.: 101, 103, 106 and 107 have the following characteristics:

Construction Styles:	Basic No.	Type Winding	Shape
	101	Inserted Tabs	Flat
	103	Extended Foil	Flat
	106	Inserted Tabs	Round
	107	Extended Foil	Round

I.R.E. Show Booth 2632

Tolerance: The standard capacitance tolerance is ± 20%. Closer tolerances can be specified.

Electrical Characteristics: Operating range for Mylar capacitors—from —55° C to +85° C and to +125° C with voltage de-rating.

Dissipation Factor: The dissipation factor is less than 1% when measured at 25° C and 1000 CPS or referred to 1000 CPS.

Insulation Resistance:	Temperature	1R x mfd	Maximum IR Requirements
	25° C	50,000	15,000 megohms
	85° C	1,000	6,000 "
	125° C	50	300 "

Pyramid Mylar capacitors are subject to the following tests:

Test Voltage—Mylar capacitors shall withstand 200% of rated D.C. voltage for 1 minute at 25° C.

Life Test—Mylar capacitors shall withstand an accelerated life test of 250 hours with 140% of the voltage rating for the test temperature. 1 failure out of 12 is permitted.

Humidity Test—Mylar capacitors shall meet the humidity requirements of MIL-C-91A specifications.

Complete engineering data and prices for Pyramid Mylar and Tantalum Capacitors may be obtained from Pyramid Research and Development Department.

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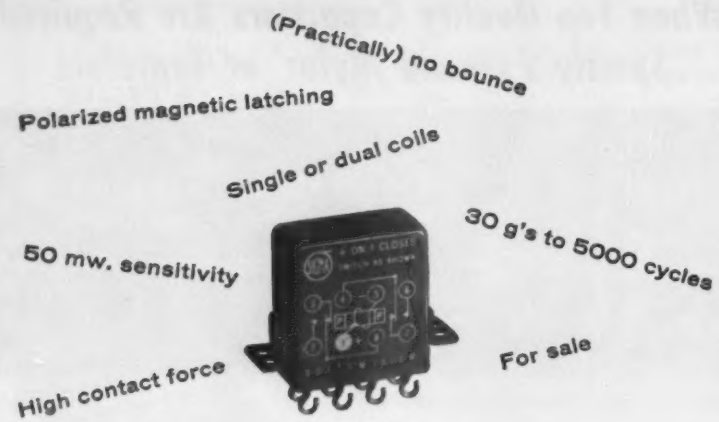

Sigma Series 32 Relay

. . . and it's

NOW AVAILABLE ACTUAL SIZE

Sigma Series 32 DPDT polarized magnetic latching relays are now in full production and for sale actual size. Your incoming inspection dept. no longer need maintain postage stamps, paper clips, coins, matchbooks, loupes, grapes and other popular size standards; Sigma manufacturing tolerances and an electronic sanforizing process hold max. "32" dimensions to 0.800" x 0.400" x 0.900" high (including wiring diagram printed on side). You can even measure a "32" today and come back a week later and it will still be the *same* size. *That's* uniformity you can work with!

Now that the problem of dimensional parameters has been conquered with characteristic Sigma efficiency, other "32" facts of general interest deserve mention. If you're looking for vibration immunity, a "32" probably has more in its favor than any other presently available relay of this type (if we've correctly gauged the rest of the field). Associated shock tests show that the contacts won't open, with the relay energized or de-energized, under 100 g wallops. Operate time of the "32" is 2 to 20 milliseconds, depending on overdrive, and max. contact bounce is 300 microseconds. Standard operating sensitivities are 50 mw. for a single-coil relay, 100 mw. for each coil of a dual-coil relay.

Choice of either single or dual coil versions gives you some freedom in circuit hook-up: where the single-coil type must have a signal of both the correct polarity *and* magnitude to cause armature transfer from one fixed position to the other, a dual-coil "32" can be made to trip simply by changing the power level (assuming the presence of a reference bias and that you've got the + and − on the right pins).

Production of the Series 32 is now going full blast and they're all coming through with a circuit diagram instead of "Merry Christmas" printed on the side. Goodly quantities are deliverable right now and nothing would please us more. If you're still not clear on the size reference problem, write for the "32" bulletin.

IT'S BIGGER THAN BOTH OF US—WE'LL BE THERE AT BOOTH 2631-33.

SIGMA

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62 Pearl St., So. Braintree 85, Mass.

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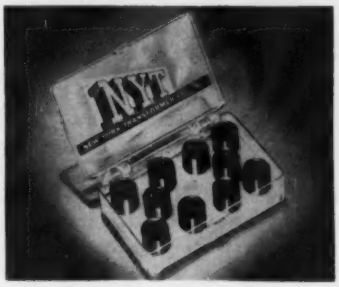
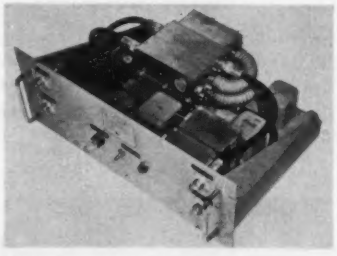
weight (1/30 oz). Smooth bearing-loads, constant velocity, and absolute zero-backlash are bonuses from the helical design that allows these couplings to be so compact. (Similar proportions are available for other shaft sizes.) Maximum reliability is assured by each coupling's being ground from a single solid piece of material (no solder-joints, pins, screws, or rivets to come loose). **Circle 503 on Reader Service Card.**



Pulse Transformers in kit of ten

NEW YORK TRANSFORMER CO., Alpha, N. J. The NYT miniature pulse transformer laboratory kit consists of 10, three-winding pulse transformers packaged in a clear, plastic box. The transformers provide a range of pulse widths from 0.1 to 10 μsec. The range can be extended to 40 μsec by wiring the third winding of two transformers in series. **Circle 504 on Reader Service Card.**



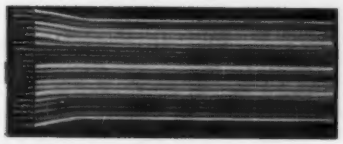
Antenna Multicoupler rack mounting

RESDEL ENGINEERING CORP., 330 S. Fair Oaks Ave., Pasadena, Calif. A new antenna multicoupler will pass the frequency range between 200 and 400 mc from a single wideband antenna to four separate-channel receivers. By cascading multicouplers the same antenna will feed addi-

tional receivers. Used as a laboratory wideband amplifier, the multicoupler will feed signals of one signal generator to four independent r-f amplifiers or receivers. Isolation between outputs is 45 db minimum. Gain is 10 db for each channel and uniformity of response is ±2 db. **Circle 505 on Reader Service Card.**

VHF/F-M Tuner
two versions

PLESSEY INTERNATIONAL LTD., Ilford, Essex, England. The compact P.B.2. vhf/f-m tuner is designed around a double triode, one section of which is used as an r-f amplifier and the other as a self-oscillating mixer. Unit employs eddy-current tuning and is available in two main versions, one having a tuning range of 87-101 mc and the other, 87-108 mc. There are no oscillator drift problems with the unit. **Circle 506 on Reader Service Card.**



Bonded Cable
flexible use

PHALO PLASTICS CORP., 530 Boston Turnpike, Shrewsbury, Mass. Codastrip, the company's new flat bonded cable, with each conductor individually colored, now is run in a wide range of sizes. Heavier wall constructions are available, and different wire sizes can be combined in the same cable. **Circle 507 on Reader Service Card.**

Variable Speed Drive
miniature unit

HUMPHREY INC., 3794 Rosecrans St., San Diego 10, Calif. The Servotran variable-speed drive offers fre-

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FM

For years Marconi's have been specialists in precision instrumentation for FM systems. Here are two models from our extensive range, designed to answer your FM measuring problems. Ask for leaflets B 149 for complete details.

CARRIER DEVIATION METER Model 791D

Crystal locking facilities in this new deviation meter insure freedom from microphony, and allow measurement of FM hum and noise in VHF and UHF communication and broadcast transmitters.

MEASURES DEVIATION: 200 cps to 125 kc in four ranges; extended down to 10 cps using external readout. Indicates positive or negative deviation at the turn of a switch.

IN-BUILT DEVIATION STANDARD, crystal controlled, for sustained accuracy.

CARRIER FREQUENCY RANGE: 4 to 1,024 mc, directly calibrated.

MODULATION FREQUENCY RANGE: 50 cps to 35 kc.

FM/AM SIGNAL GENERATOR Model 995A/4

Narrow-deviation FM, stepped and extra-fine incremental tuning, and a high-stability low-noise output make this versatile VHF generator particularly suitable for mobile radio testing.

FREQUENCY RANGE: 1·5 to 220 mc with crystal check points above 13·5 mc. Less than 0·002% short-term drift.

DIRECT-READING INCREMENTAL TUNING: Stepped control up to ± 40 kc, extra-fine continuous control up to ± 15 kc.

OUTPUT RANGE: 0·1 µv to 100 mv at 52 and 75 ohms.

MODULATION: FM: deviation monitored and variable from 0 to 5 and 0 to 15 kc. AM: monitored and variable up to 50%. Modulation frequencies, 400 cps, 1 and 1·5 kc.

SPURIOUS FM ON CW: Less than 25 cps deviation.

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SOME NOT SO PLEASANT VARIATIONS

"Variety is the spice of life", a canned-food manufacturer tells us. This holds true in a great many fields. In mathematics, few studies are as fascinating as the calculus of variations. In music, what could be more pleasant than Brahms' "Variations on a Theme by Haydn"?

But in electricity, equipment designers are often faced with some not so pleasant variations in line voltage. Neither mathematics nor music is of much help here.

The best solution to date is a Raytheon custom magnetic-amplifier voltage regulator which, in a weather radar, successfully stabilizes single-phase line variations ranging from 105 to 125 volts, and holds them to within ±1% of 115 volts. This is in spite of the fact that line frequency variations are as much as ±5%, and ambients from −45 F to +45 F.

Raytheon engineers have solved a variety of such voltage regulation problems. Why not tell them yours? Simply contact:

VOLTAGE REGULATOR MAN
Raytheon Manufacturing Company
Magnetic Components Product Dept.
Section 6120
Waltham 54, Massachusetts

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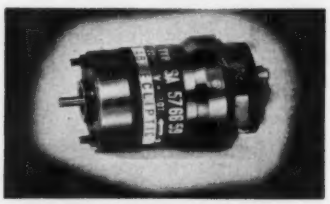
quency response equivalent to a hydraulic system and triple that of an electrical system in a mechanical drive weighing only 1¾ lb. The drive without motor is only 3¾ in. long by 2 in. in diameter. Applications include actuators, computers, recorders, integrators and in airborne instrumentation where low torque shifting, high efficiency, wide speed range and low noise levels are important. **Circle 508 on Reader Service Card.**

Gearhead has clamp device

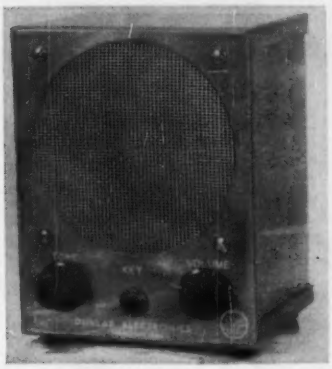
BOWMAR INSTRUMENT CORP., 8000 Bluffton Road, Ft. Wayne, Ind. Precision servo motor gearhead 750GH now adapts instantly to size 8 motors with a new style, double-lipped clamp. Unit is particularly advantageous since present BuOrd style and caps on size 8 servo motors do not have tapped holes for screw mounting gearheads. The motors, however, do have a groove which was used for attaching gearheads with ears, dogs and other multipart devices. The same groove is used with the new Bowmar clamp. **Circle 509 on Reader Service Card.**



D-C Motor constant speed

CARTER MOTOR CO., 2762 A W. George St., Chicago 18, Ill., has announced a new, small, constant speed d-c motor equipped with a governor that controls shaft speed variation within 1 percent. Overall dimen-

sions are approximately 1½ in. by 3 in., including the shaft which protrudes about ½ in. beyond the motor frame proper. Weight is about 7 oz. Motor is rated up to 1/100 h-p at 4,500 to 9,000 rpm, with a rotor torque of 3.5 oz in. for intermittent duty. **Circle 510 on Reader Service Card.**



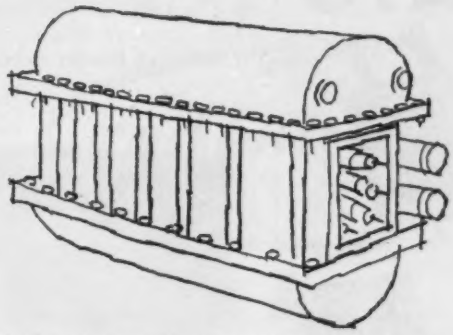
Oscillator for code practice

DUNLAP ELECTRONICS INC., 764 Ninth St., Des Moines, Iowa. The CPT-1 is a battery operated transistorized code practice oscillator designed to be used in learning and obtaining proficiency in code. It can also be used as an audio signal source of varying frequency. It features variable tone control and variable volume control with a 4-in. permanent magnet speaker. **Circle 511 on Reader Service Card.**

Encoder for rugged duty

DATEX CORP., 1307 S. Myrtle Ave., Monrovia, Calif., has available a shaft position encoder designed to operate under extreme ranges of environmental conditions. Model C-701 provides up to 1,024 positions per shaft rotation, and features high resolution and accuracy. The encoder is a sealed unit, utilizing O-

A PROBLEM OF UTMOST GRAVITY



RAYTHEON-DESIGNED, HIGH VOLTAGE DC MAGNETRON POWER SUPPLY

Weight, in one form or another, seems to be a concern of most of us today. While astronauts contend with the problem of "none at all", designers of electronic components continually face the problem of "too much".

An aircraft manufacturer recently called on Raytheon to design a 10,000-volt, 60-kva, 400-cycle, filtered DC magnetron power supply for high-temperature airborne-radar application. Several designs were available, but their weight -- more than 1,800 pounds -- put them in the lead balloon class.

Our engineers, thoroughly experienced in the field of fluorochemical transformer design, were able to get the "lead" out, about 1,200 pounds of it, and to come up with a unit (shown above) weighing only 650 pounds.

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Balanced rotary element with radial thrust bearings at both ends of shaft operated by the balanced pull of twin coils: minimizes effect of gravity, shock and vibration, permitting reliable operation where other relays fail.

Rugged frame and header assembly of bridge type construction: minimizes distortion and permits reliable operation under vibration, shock and temperature extremes.

Reliability inspections and tests cover parts, materials and every phase of assembly.

Permanently adjusted, ultrasonically super cleaned and hermetically sealed under ideal conditions: safe from contamination.

Engineering Data

Insulation resistance: 100 megohms, min.
Insulation to ground: 500 VAC, RMS.
Shock: 100g for 11ms.
Vibration: 20g to 2000 cps
Operate Time: 5 ms. max. with nominal voltage
Release Time: 3 ms. maximum.
Temperature Range: 65°C. to 125°C.

Available with required types of terminals and mountings to meet a wide range of applicable military specifications.

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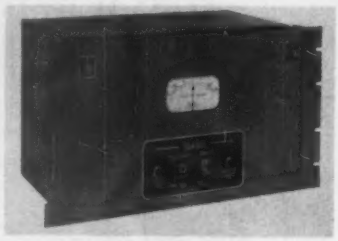
ring seals on the shaft and case. It will operate in the range −65 to +162 F, and conforms to MIL-Std specifications for humidity, salt spray and vibration. It operates at ±8 g to 1,000 cps and under 100 g steady state in longitudinal axis. **Circle 512 on Reader Service Card.**



Frequency Monitor
FCC-approved

GATES RADIO CO., Quincy, Ill., has announced an a-m frequency monitor that guards the position of a broadcaster's transmitter frequency with accuracy of ± 2 parts per million. A new vacuum-type crystal unit eliminates air gap adjustments and speeds installation. A blanket heater provides even heat to crystal and oscillator components. The signal may be connected direct to the monitor, or transmitter 20 miles or more from remote control (unattended) transmitter sites. **Circle 513 on Reader Service Card.**

Synchros
MIL type

KETAY DEPT., Norden Division, United Aircraft Corp., Commack, L. I., N. Y., is producing new precision MIL-type synchros. Units offer improved accuracy, improved environmental characteristics, higher torque gradients and lower nulls. Synchro receivers, transmitters and

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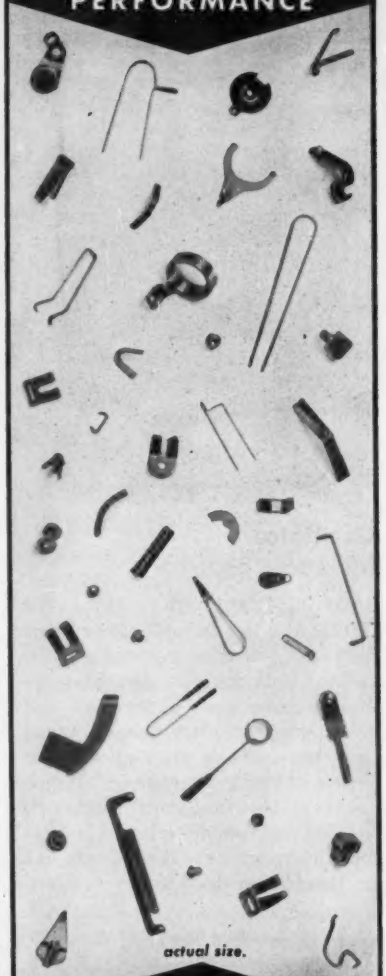

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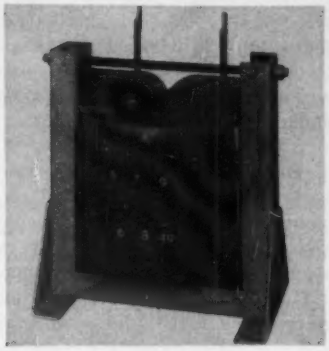
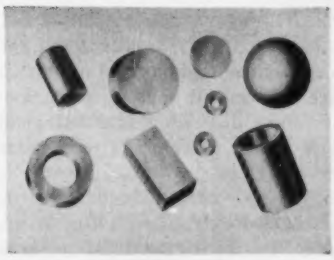
differentials for both torque and control systems are available. Frame sizes from 08 to 23 have been designed for 400 cps and 60 cps applications. **Circle 514 on Reader Service Card.**



Magnetic Amplifier
high power output

VICKERS INC., 1815 Locust St., St. Louis 3, Mo. The Super Power 1290 series of power magnetic amplifiers is available in 18 standard sizes, from 500 va to more than 32 kva. A major feature is the tapewound gapless core, which permits a minimum of control ampere-turns and eliminates the irregular performance resulting from air gaps. **Circle 515 on Reader Service Card.**



Ceramic Element
high stability

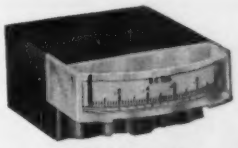
U. S. SONICS CORP., 625 McGrath Highway, Somerville, Mass., has developed U. S. 100, a new type of ceramic transducer element that is extremely stable over a wide temperature range. Typical fields of applications include missile systems, underwater sounding, level indicators, sound reproduction, telemetering and airborne sensing circuits. **Circle 516 on Reader Service Card.**

redesigning?

1/3 the panel area, same scale length

* MODEL 1145

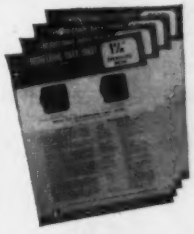
side indicators



* MODEL 1135

* MODEL 1120

Save space on crowded, complex panels *without* sacrificing readability or accuracy. Model 1145 provides accuracy and scale length of conventional 4½" meters with ⅓ the panel area and far less weight . . . Model 1135 compares with conventional 3½" meters. For horizontal or vertical mounting. Feature dust-proof cases with clear plastic covers. Center, top or bottom zero position and other variations so pointer movement will conform with "human engineering" principles. Side indicator panel meters are an original International Instruments development, and *only* International offers you a complete line with scale lengths of 2.7", 2.1" and 1.2"! Supplied in a wide variety of standard and special ranges.



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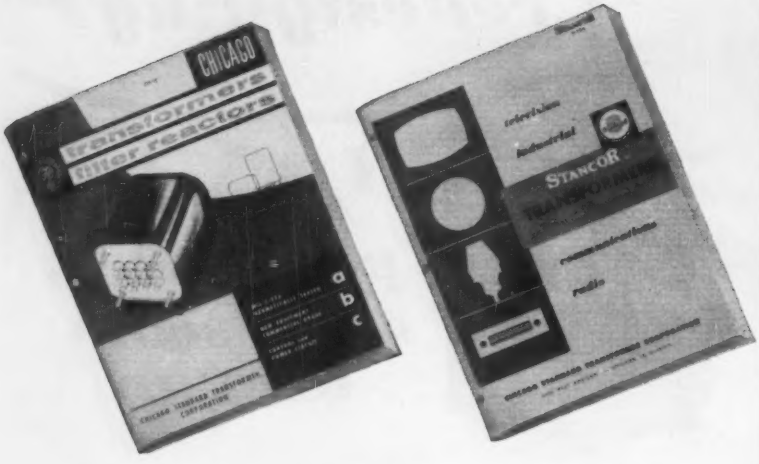

these useful

TRANSFORMER CATALOGS

These two reference books are invaluable aids to design engineers. They list over 1,100 CHICAGO STANDARD *stock* transformers . . . hermetically sealed and open mounting units, for a wide range of military and industrial applications . . . with detailed electrical and physical specifications given on each one.

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Literature of

MATERIALS

Polyester Glass Laminates. Continental-Diamond Fibre Corp., Newark, Del., has available a new bulletin on low-cost insulation sheets and fabricated parts of polyester glass-base Dilecto and Celoron laminates. **Circle 530 on Reader Service Card.**

Ceramic Insulator. Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif. Bulletin 1590A covers Ceramicite, a hermetic sealing material capable of withstanding severe physical and thermal shocks without leaking or cracking. **Circle 531 on Reader Service Card.**

COMPONENTS

Transistor Brochure. General Transistor Corp., 91-27 138th Place, Jamaica 35, N. Y. Brochure G-150A covers specifications on a line of improved high frequency germanium alloyed junction transistors. **Circle 532 on Reader Service Card.**

Pulsed Magnetic Components. Levinthal Electronic Products, Inc., Stanford Industrial Park, Palo Alto, Calif. Facilities for the design, development and manufacture of pulsed magnetic components are discussed in a recent 4-page folder. **Circle 533 on Reader Service Card.**

Rotary Relay. Couch Ordnance, Inc., 3 Arlington St., North Quincy, Mass. Data sheet 1 includes mechanical, electrical and environmental specifications for the type RC rotary relay. **Circle 534 on Reader Service Card.**

EQUIPMENT

Electronic Computer. Royal McBee, Westchester Ave., Port Chester, N. Y. LGP-30 general purpose computer brochure S-526R1 gives specifications, basic features, illustrates major compo-

the Week

nents and lists applications. **Circle 535 on Reader Service Card.**

A-C Network Analyzer. General Electric Co., Computer Department, Phoenix, Ariz. A 4-page folder illustrates and describes the model 307 miniaturized a-c network analyzer and its components. **Circle 536 on Reader Service Card.**

Range and Balance Unit. Computer Engineering Associates, Inc., 350 N. Halstead, Pasadena, Calif. Bulletin BR 111.1 describes a new range and balance unit which balances out small inequalities in bridge arm resistances. **Circle 537 on Reader Service Card.**

Temperature Test Chambers. Statham Development Corp., 1845 Pontius Ave., Los Angeles 25, Calif. Lightweight, bench-type temperature test chambers are illustrated and described in a 4-page folder. **Circle 538 on Reader Service Card.**

Automation. Control Design and Fabricate, Inc., 30725 Twelve Mile Road, Farmington, Mich. A 4-page brochure illustrates and describes typical custom control centers for all types of automation systems and automatic machinery. **Circle 539 on Reader Service Card.**

Digital Servo Indicator. Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio. A two-page bulletin describes the features, applications and specifications of the model 143 direct reading digital servo indicator. **Circle 540 on Reader Service Card.**

FACILITIES

Plant and Product. Farwell Metal Fabricating, 81 West Fairfield Ave., St. Paul 7, Minn. A new and informative brochure on "Space Age" contract manufacturing shows the scope of the company's manufacturing capabilities in a quick reference manual. **Circle 541 on Reader Service Card.**

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Has 5-inch flat faced, post accelerated CRT and illuminated, calibrated screen. 4 megacycle band width vertical amplifier. 10 millivolt peak-to-peak per cm deflection sensitivity. Triggered or recurrent sweeps—variable from 2 cps to 30 kc. Exceptionally slow sweeps provided through use of external capacitors. Built-in direct reading, regulated square-wave voltage calibrator. AC or DC vertical amplifier inputs. Also features new "chimney effect" cooling technique for greatly improved reliability. **$425**

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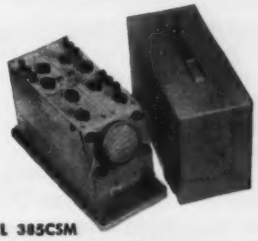
19-inch Rack Mount Oscilloscope with 3-inch CRT. Identical horizontal and vertical amplifiers DC to 500 kc. Triggered or recurrent sweeps from 1 cps to 100 kc. Provides for exceptionally slow (10 seconds or more) sweep rates through use of external capacitors. 10 millivolts RMS per inch vertical sensitivity (14 horizontal). Shock mounted. Internal or external locking. **$379**



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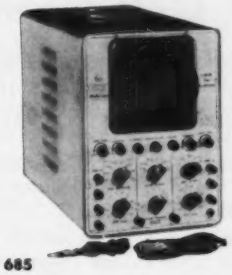

MODEL 685

IDENTICAL AMPLIFIERS WITH 5" TUBE

Portable Oscilloscope with 5-inch CRT and illuminated calibrated screen. Features identical amplifiers DC to 750 KC—1 cycle to 750 KC. Rise time approx. .5 microseconds. Sensitivity 20 MV RMS vertical (30 horizontal). Recurrent or Triggered sweep. Frequency coverage from 1 cps to 100 kc in 5 calibrated decade ranges with vernier control of 10 to 1. Has External Sync for synchronizing and triggering the built-in sweep generator from external signals. Shock mounted. **$313**

A demonstration or technical literature is available at your request.

RD INSTRUMENTS
FOR RESEARCH AND DEVELOPMENT

The Hickok Electrical Instrument Company • 10514 Dupont Ave. • Cleveland 8, Ohio

Exhibited at Booth 3516—1518 IRE Show

IRE President Wears 3 Hats

THIS YEAR'S president of the Institute of Radio Engineers is Austrian-born Ernst Weber, 58, president since 1957 of the Polytechnic Institute of Brooklyn. Weber takes on a year of constant travel and a third presidential responsibility—he also heads the Polytechnic Research & Development Co.—and adds another rift in a career already split among education, research and industry.

The genial and indefatigable Weber found his earliest interests in philosophy, but was trained as an engineer and researcher. After secondary school, he enrolled at two colleges, working toward his Ph. D. at the University of Vienna (1926) and pursuing his technological training at Vienna's Technical University. "Times were hard then," he says, "and I could make a little money tutoring at the technical college."

He took his Dipl. Ing. there in 1924 and went to work as a researcher for Siemens-Vienna, continuing to study for his Sc. D., which he got in 1927. He specialized in high-frequency and microwave research, collected a sizable portfolio of patents in that field. In 1929 he transferred to Siemens headquarters in Berlin, remaining there only a year. A friend told him that Brooklyn Poly had a visiting professorship open, and he came to the U. S. in 1930. Except for vacations, he's been here ever since.

As an educator, Weber has worked mostly with graduate studies in engineering, and with research. He was instrumental in the establishment of Poly's million-dollar Microwave Research Institute, was research v-p of the school when the death of Harry Rogers in June 1957 pushed him into the presidency.

Out of the college's wartime microwave research grew Polytechnic Research & Development, started in 1943 to fabricate metallized glass attenuators which the school's radar researchers had developed. Neither glass nor metal fabricators would handle the job, so the school set up its own production facility. The firm is now a $4-to-$5-million corporation whose profits inure to stockholders—with the school holding most of the stock.

"Business is not too much different from the field of education," Weber comments. "In either case, you get people to do things they like, or get them to like the things they do." Brooklyn Poly's mushrooming growth attests the success of his philosophy.

Weber was married in 1936 to an American woman, also an Sc. D. (in physical medicine). Joint interests—besides the rich ones of the arts and sciences—include a place on Candlewood Lake, near Milford, Conn. "It's a consuming hobby," Weber smiles; "we like our view of the lake—which means I cut trees constantly to keep the view clear." The Doctors Weber also love mountainclimbing, expect to hazard Mt. Hood "this year—after Wescon."

Engineers Set for Convention

A COMPREHENSIVE 54-session program has been arranged for the 1959 IRE National Convention on March 23-26 in New York City. Thirty-three sessions will be held at the Waldorf-Astoria Hotel and 21 at the New York Coliseum. (In listing the program, locations are referred to as WA and C, respectively.) An attendance of 55,000 engineers and scientists is expected.

Highlighting the technical program will be a special symposium on Tuesday evening, March 24, in which the nation's leading experts will discuss "Future Developments in Space".

The full program of papers and authors follows:

Monday Afternoon
March 23

1. Adaptive Control Processes and Allied Systems (WA)

On Adaptive Control Processes, by R. Bellman and R. E. Kalaba, The Rand Corp.

A Dynamic Programming Approach to Adaptive Control Processes, by M. Freimer, Lincoln Lab, MIT.

On the Optimum Synthesis of Multipole Systems in the Wiener Sense, by H. C. Hsieh and C. T. Leondes, U. of Calif.

On Adaptive Control Systems, by L. Braun, Jr., Polytech. Inst. Brooklyn.

Extension of Phase Plane Analysis to Quantized Systems, by P. H. Ellis, Sperry Gyroscope.

2. Vehicular Communications (WA)

An Analysis of Radio Flutter in Future Communcations, by N. W. Feldman, U. S. Army Signal R&D Lab.

Radio Set, AN/GRC-59, Rugged, Reliable Design for Tactical Usage, by J. C. Shannon, Philco Corp.

A New Approach to Compactness in Mobile Radiotelephone Design, by W. Ornstein, International Systcoms Ltd.

A New Manual Mobile Telephone System, by A. F. Culbertson, Lankurt Electric Co. Inc.

Performance of "Low-Plate-Potential" Tube Types at Mobile-Communications Frequencies, by R. J. Nelson and C. Gonzalez, RCA.

3. Engineering Writing and Speech (WA)

Using the Psychological Approach in Scientific Writing, by J. L. Kent, Datex Corp.

An Effectual Approach to an Orally Presented Paper, by I. J. Fong, Minneapolis, Minn.

A Self-Improvement Program for Engineering Writers, by A. H. Cross, Raytheon Mfg.

Read Your Speech, by E. W. Still, GE.

Subjectivity versus Objectivity in the Technical Report, by S. Cohen, Ampex Corp.

4. Radio Frequency Interference (WA)

Standard Measurement Parameters for Phenomena Distributed in Time and Frequency, by E. W. Chapin, FCC.

Magnetic Field Pickup for Low-Frequency Radio-Interference Measuring Sets, by M. Epstein and R. B. Shulz, Armour Res. Found., Illinois Inst. Tech.

Microwave Duplexer Tube Characteristics

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STORAGE BATTERIES

Under Spurious Radiation Conditions, by I. Reingold, U. S. Army Signal R&D Lab.

Technical Considerations in the Assignment of Operating Frequencies in a Communications System, by O. M. Salati, U. of Penna. and R. A. Rosien, Hughes Aircraft Co.

Precipitation Static at High Altitude, by L. A. Hartman and F. B. Pogust, Airborne Instruments Lab.

Precipitation-Generated Interference in Jet Aircraft, by R. L. Tanner and J. E. Nanevicz, Stanford Res. Inst.

5. Engineering Management Techniques (WA)

The "Maximum" Manager in Research and Development, by M. A. Williamson, Penn. State U.

Marketing Factors in Research and Development, by H. M. Rainie, Jr., Stewart, Dougall and Associates.

Obtaining Capital for the Smaller Electronics Firm—Methods and Pitfalls, by C. M. Bower, Utilities and Industries Management Corp.

Simulation Techniques for Understanding R & D Management, by E. B. Roberts, MIT.

6. Production Techniques (C)

Microcircuitry—A New Approach to Miniaturization, Producibility, and Reliability, by W. D. Fuller, Varo Mfg. Co., Inc.

Insulated Flexible Printed Wiring Techniques, by W. B. Wilkens, Sanders Associates, Inc.

A Semiautomatic Transistor Testing Machine, by E. Millis, Texas Instruments Inc.

The Development of Automatic Machinery for Making Electron-Tube Stems, by M. M. Bell, RCA.

Microminiaturization, by D. W. Moore, Servomechanisms, Inc.

7. Navigation and Traffic Control (C)

Loran-B Precision Navigation, by W. J. Romer, U. S. Coast Guard.

A Synthetic Future Environment for Analysis of Radar Beacon System Capacity, by A. Ashley and F. H. Battle, Jr., Airborne Instruments Lab., Inc.

Air Traffic Control Computer, by A. G. Van Alstyne and M. H. Nothman, Gilfillan Bros., Inc.

Use of Airport Surface Detection Radar as a Tool in Airport Research, by M. A. Warskow, Airborne Instruments Lab., Inc.

An Improved Instrument Low Approach System Compatible with Tacan, by M. Karpeles and E. G. Parker, ITT Labs., Inc.

8. Electronic Devices (C)

The Field Effect Tetrode, by H. A. Stone, Jr., Bell Telephone Labs., Inc.

A Theory of the Tecnetron, by A. V. J. Martin, Carnegie 'nst. Tech.

A Simple and Flexible Method of Fabricating Diffused *NPN* Silicon Power Transistors, by L. D. Armstrong and H. D. Harmon, RCA.

A Twenty-Ampere Switching Transistor, by T. P. Nowalk, Westinghouse Electric Corp.

Drift Considerations in Low-Level Direct-Coupled Transistor Circuits, by J. R. Biard and W. T. Matzen, Texas Instruments, Inc.

Video Crystal Tester, by Y. J. Lubkin, Airborne Instruments Lab.

Tuesday Morning
March 24

9. New Techniques for Analysis (WA)

Simplified Method of Determining Transient Response from Frequency Response of Linear Networks and Systems, by V. S. Levadi, Ohio State U.

A New Method of Analysis of Sampled-Data Systems, by A. Papoulis, Polytech. Inst. Bklyn.

Statistical Filter Theory for Time-Varying Systems, by E. C. Stewart and G. L. Smith, Ames Res. Center.

On the Phase Plane Analysis of Nonlinear

Time-Varying Systems, by R. Whitbeck, Cornell Aeronaut. Lab., Inc.

On the Use of Growing Harmonic Exponentials to Identify Static Nonlinear Operators, by J. H. Lory, D. C. Lai, and W. H. Huggins, The Johns Hopkins U.

10. Nuclear Instrumentation Techniques—I (WA)

A Transistorized Nuclear Reactor Count Rate Channel, by J. H. Cawley, General Dynamics Corp.

Transistorized Source-Range Reactor Instrumentation, by R. R. Hoge, Bendix Aviation Corp.

A Two-Dimensional Kicksorter, by R. Chase, Brookhaven National Lab.

A Transistorized Pulse Height Analyzer, by R. T. Graveson, U. S. A. E. C.

11. Broadcasting—I (WA)

FM Carrier Techniques in the RCA Color Video Tape Recorder, by R. D. Thompson, RCA Labs.

A Deleter-Adder Unit for TV Vertical Interval Test Signals, by J. R. Popkin-Clurman and F. Davidoff, Telechrome Mfg. Corp.

An Electro-Servo Control System Capable of Correcting Zero Point Zero Five Microsecond Rotational Errors, by W. Barnhart, Ampex Corp.

Transistorized Video Switching, by J. W. Wentworth, C. R. Monro, and A. C. Luther, Jr., RCA.

A New Approach to Low Distortion in a Transistor Power Amplifier, by H J. Paz, RCA.

12. Contributions to Stereo Sound Reproduction (WA)

The "Null Method" of Azimuth Alignment in Multitrack Magnetic Tape Recording, by A. G. Evans, RCA.

Three-Channel Stereo Playback of Two Tracks Derived from Three Microphones, by P. W. Klipsch, Klipsch and Associates.

Study of a Two-Channel Cylindrical Ceramic Transducer for Use in Stereo Phonograph Cartridges, by C. Germano, Clevite Electronic Components.

The Single Stereophonic Amplifier, by B. B. Bauer and J. M. Hollywood, CBS Labs.

A Frame-Grid Audio Pentode for Stereo Output, by J. L. McKain and R. E. Schwab, Sylvania Electronic Tubes.

Design Considerations for Stereo Cartridges, by J. H. McConnell, Electro-Sonic Labs., Inc.

Status Report on Stereophonic Recording and Reproducing Equipment, by W. S. Bachman, Columbia Records.

13. Engineering Management—II (WA)

The Advanced Research Projects Agency—Operations and Plans, by J. E. Clark, The Pentagon.

Planning and Managing a Multi-Company Electronic Systems Program, by E. G. Fubini, Airborne Instruments Lab.

Intra-Company Systems Management, by H. H. Goode, U. of Michigan.

14. Medical Electronics—I (C)

A Data System for Physiological Experiments in Satellites, by M. A. McLennan, Wright Air Devel. Center.

A Logical Structure for Diagnosis Based on Probability, by S. Rush, Syracuse U.

Microwave Radiation as a Tool in Biophysical Research, by C. Susskind, B. S. Jacobson, and S. B. Prausnitz, U. of Calif.

The Reliability Problem in Machines and in Nature, W. B. Bishop and J. A. LaRochelle, Air Force Cambridge Res. Center.

Respiratory Control of Heart Rate: Laws Derived from Analog Computer Simulation, by M. E. Clynes, Rockland State Hospital.

15. Land and Space Electronics (C)

Application of Satellite Doppler Shift Measurements.

Part I—Satellite Frequency Measurements, by O. P. Layden and H. D. Tanzman,

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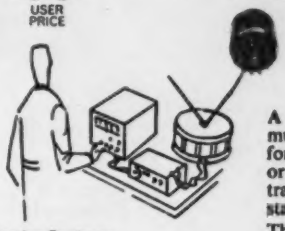

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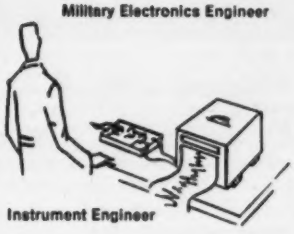

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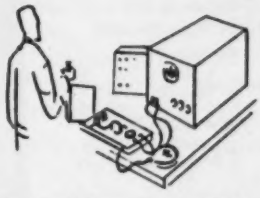

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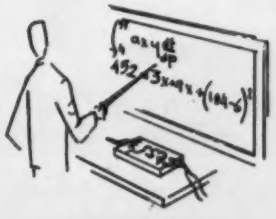

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Part II—Slant Range at Nearest Approach, by H. P. Hutchinson, U. S. Army Signal R&D Lab.

Sputnik II as Observed by C-Band Radar, by D. K. Barton, RCA.

Free-Rotor-Gyro Stabilized Inertial Reference Platform, by T. Mitsutomi, North American Aviation, Inc.

Ground Clutter Isodops for Coherent Bistatic Radar, by H. A. Crowder, Hughes Aircraft Co.

Land Vehicle Guidance by Radar, by Y. Chu and P. N. Buford, Westinghouse.

16. Panel: Widening Horizons in Solid-State Electronics (C)

Ferrites and Microwave Solids, by C. L. Hogan, Motorola, Inc.

Solid-State Energy Sources, by W. J. Vander Grinten, GE.

Advanced Semiconductors, by W. M. Webster, Jr., RCA.

Tuesday Afternoon

17. Information Theory (WA)

Information Rate from the Viewpoint of Inductive Probability, by L. S. Schwartz, B. Harris, and A. Hauptschein, NYU.

Binary Relay Communication and Decision Feedback, by J. J. Metzner, NYU.

Results of a Geometric Approach to the Theory and Construction of Nonbinary, Multiple Error, and Failure Correcting Codes, by B. M. Dwork and R. M. Heller, Westinghouse.

An Application of the Theory of Games to Radar Reception Problems, by N. J. Nilsson, Rome Air Develop. Center.

Perception Simulation Experiments, by F. Rosenblatt, Cornell Aeronaut. Lab., Inc.

18. Nuclear Instrumentation Techniques—II (WA)

A Transistorized Cold Cathode Decade Counter, by H. Sadowski and M. E. Cassidy, AEC.

A High Sensitivity Semiconductor Diode Modulator for D-C Current Measurement, by H. E. DeBolt, Fairchild Camera and Instrument Corp.

Control Concepts for Nuclear Ramjet Reactors, by R. E. Finnigan, Livermore Lab.

Low Background Nuclear Counting Equipment, by H. D. LeVine, R. T. Graveson, and A. L. Charlton, AEC.

19. Broadcasting—II (WA)

Possibilities of Major Simplifications in Color Television Live Cameras and Recording Devices Through the Use of Chroma Field Switching and Subsequent Automatic Color Balance, by W. L. Hughes, Iowa State College.

Report of TASO Committee 3.3 on Correlation of Picture Quality and Field Strength, by C. M. Braum, Joint Council on Educational TV, and W. L. Hughes, Iowa State College.

Report of TASO Committee 5.4 on Forecasting Television Service Fields, by A. H. LaGrone, U. of Texas.

A New Wireless Microphone for TV Broadcasting, by P. K. Onnigian, KBET-TV.

A Television Program Automation System Using Beam Switching Tubes with Shift Register Circuitry, by F. C. Grace, Visual Electronics Corp.

20. Speech and Circuits (WA)

Speech Bandwidth Compression with Vocoders, by F. H. Slaymaker, Stromberg-Carlson Co.

Audio Applications of a Sheet-Beam Deflection Tube, by J. N. Van Scoyoc, Armour Res. Found.

A Drift-Free Direct Coupled Amplifier Utilizing a Clipper-RC Feedback Loop, by J. N. Van Scoyoc and E. S. Gordon, Armour Res. Found.

The Application of the Voltage Variable Semiconductor Capacitor in Automatic Sweep Circuits and "Signal Seeking" Receivers, by J. Black, Pacific Semiconductors Inc.

An Analysis of a Transistorized Class "B" Vertical Deflection System, by Z. Wiencek and J. E. Bridges, Warwick Mfg. Corp.

21. Medical Electronics—II (C)

Recent Advances in Medical Electronics, by V. K. Zworykin, RCA Labs.

An Electronic Electrode, by J. W. Moore and J. del Castillo, Nat. Inst. Health.

Transistor Waveform Generators, by G. N. Webb and R. N. Glackin, The Johns Hopkins Hosp.

Cardiac Pacing-Stimulation by Very Portable Equipment, by D. G. Kilpatrick, Atronic Products, Inc.

The Design of a Fetal Phonocardiotachometer, by H. S. Sawyer, Airborne Instruments Lab., Inc.

22. Reliability Techniques (C)

Development and Utilization of Redundant Systems, by S. Nozick, Hughes Aircraft Co.

High Reliability Statistically Demonstrated, by B. L. Weller, Vitramon, Inc.

Circuit Redundancy, by J. H. S. Chin, Sperry Gyroscope Co.

An Original Reliability Program for a Development Project, by K. S. Packard, Airborne Instruments Lab., Inc.

Failure Indication Considered as a Problem in Sequential Analysis, by W. B. Bishop, Air Force Cambridge Res. Center.

23. Microwave Tubes (C)

Microwave Detection with Vacuum Tube Diodes, by N. E. Dye, J. Hessler, Jr., A. J. Knight, R. A. Miesch, and G. Papp, ITT Labs.

Priming Techniques for Reducing Jitter on Pulsed Reflex Klystrons, by P. A. Crandell, National Co., Inc.

A Multiple Frequency Local Oscillator, by C. W. Flynn, ITT Labs.

Selective Signal Suppression and Limiting in Traveling-Wave Tube Amplifiers, by H. J. Wolkstein and E. Kinaman, RCA.

A New Backward-Wave Oscillator for the 4 to 5-Millimeter Region, by J. A. Noland and L. D. Cohen, Sylvania Electric Products, Inc.

Tuesday Evening

24. Panel: Future Developments in Space (WA)

Space Philosophy, by L. V. Berkner, National Acad. of Sciences.

Engineering Needs, by F. H. Griswold, SAC.

Space Vehicles, by G. H. Stoner, Boeing Aircraft Co.

Space Engineering, by O. G. Villard, Jr., Stanford U.

Communications and Data Transmission, by G. S. Shaw, Radiation, Inc.

Space Navigation, by L. E. Root, Lockheed Aircraft Co.

Military Applications, by J. M. Gavin, Arthur D. Little, Inc.

Biophysical Problems of Space Travel, by T. C. Helvey, U. of Kansas.

Medical Aspects, by O. H. Schmitt, U. of Minnesota.

Space Science, by H. E. Newell, Nat. Aero. & Space Agency.

Wednesday Morning
March 25

25. The Statistical Theory of Signals and Circuits (WA)

Coding a Discrete Information Source with a Distortion Measure, by C. E. Shannon, MIT.

The Probability Density of the Output of a Filter when the Input is a Random Telegraphic Signal, by J. A. McFadden, Purdue U.

On the Solution of an Eigen Value Equation of the Wiener-Hopf Type Defined in Finite and Infinite Ranges, by R. Mittra, U. of Illinois.

Optimum Estimation of Impulse Response in the Presence of Noise, by M. J. Levin, Columbia U.

An Approximate Method of Computing Modulation Products, by J. L. Ekstrom, Electronic Communications, Inc.

26. Radio and Television Receivers (WA)

Considerations in Transistor Automobile Receiver Front-End Design, by R. Martinengo, Raytheon Mfg. Co.

A Five-Transistor Automobile Receiver Employing Drift Transistors, by R. A. Santilli and C. F. Wheatley, RCA.

Improvements in Detection, Gain Control, and Audio Driver Circuits of Transistorized Broadcast Band Receivers, by R. V. Fournier and D. Thorne, RCA.

Application of Rotationally Nonsymmetrical Electron Lenses to TV Image Reproduction, by D. Taylor, N. Parker, and N. Frihart, Motorola, Inc.

A High Sensitivity Ultrasonic Microphone, by P. Desmares and R. Adler, Zenith Radio Corp.

27. Component Parts—I (WA)

Progress Report on Ad Hoc Group Study on Specifications, by E. J. Nucci, OASD Res. and Eng., Pentagon.

Trend of Things to Come, by C. H. Lewis, ARDC, Andrews AFB.

Review of the Capacitor Art, by L. Kahn, Aerovox Corp.

Electronic Materials — An Industry-Wide Problem, by A. M. Hadley, Advisory Group on Electronic Parts.

A New Method for Maintaining Uniform Cooling Airflow during Maintenance and Operation, by A. Perlmutter, Sylvania Electric.

28. Digital Telemetering (WA)

Digital-to-Analog Conversion and Multiplexing, by D. Block and M. Palevsky, Packard Bell Computer Corp.

A High-Speed, Airborne Digital Data Acquisition System, by S. Cogan and W. K. Hodder, Consolidated Electrodynamics Corp.

A System for Editing and Computer Entry of Flight Test Data, by S. F. Higgins, Consolidated Electrodynamics Corp.

The Use of a Fractional Bistable Multivibrator Counter in the Design of an Automatic Discriminator Calibrator, by M. W. Williard and G. F. Anderson, Dynatronics, Inc.

Analysis of Multiplex Error in FM/FM and PAM/FM/FM Telemetry, by J. Schenck and W. F. Kennedy, AVCO Mfg. Corp.

Comments Relative to the Application of PCM to Aircraft Flight Testing, by R. S. Djorup, Epsco, Inc.

29. Symposium: Psychology and Electronics in the Teaching-Learning System (WA)

Teaching Machines, by B. F. Skinner, Harvard U.

Teaching Physics by Television, by H. E. White, U. of Calif.

Preliminary Studies in Automated Teaching, by R. F. Mager, Fort Bliss, Texas.

Problems and Possibilities of Electronic Systems in Higher Education, by C. R. Carpenter, Penn State U.

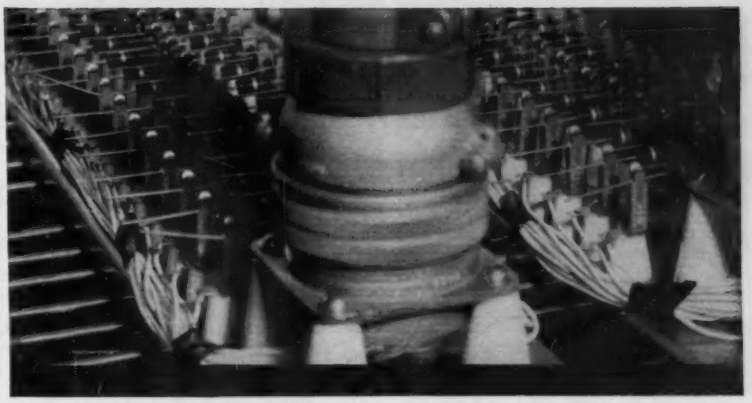
30. Communication by Scatter System (C)

Predicting the Performance of Long-Distance Tropospheric Communication Circuits, by A. P. Barsis, K. A. Norton, and P. L. Rice, Nat. Bureau of Standards.

A Study of the Economic and Technical Feasibility of Utilizing Tropospheric Scatter Links in the National Network of Korea, by C. A. Parry, Page Communications Engineers, Inc.

A Formalized Procedure for the Prediction and Analysis of Multichannel Tropospheric Scatter Circuits, by C. A. Parry, Page Communications Engineers, Inc.

Multibeam Transhorizon Tropospheric Communications, by J. H. Vogelman, J. L. Ryer-



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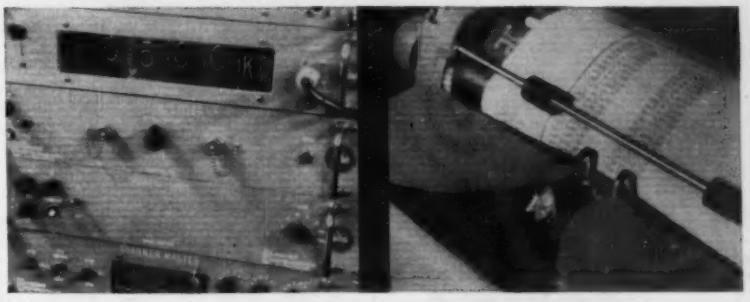

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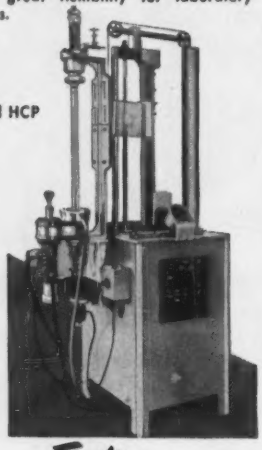

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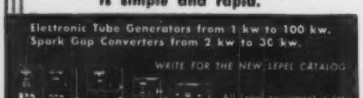

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son, and M. Bickelhaupt, Rome Air Devel. Center.

Simplified Base Band Diversity Combiner, by R. T. Adams, ITT Labs.

31. Mathematical Approaches for Reliability (C)

The Reliability Game, by R. F. Edwards, International Rectifier Corp.

Operational Reliability Model for a Reconnaissance System, by L. L. Philipson, Planning Res. Corp.

What Price Reliability? by J. Klion and J. J. Naresky, Rome Air Devel. Center.

System Efficiency and Reliability, by R. E. Barlow and L. C. Hunter, Electronic Defense Lab.

Analysis of System Reliability from the Standpoint of Component Usage and Replacement, by Mrs. B. J. Flehinger, IBM Corp.

32. Microwave Devices (C)

A Microwave Meacham Bridge Oscillator, by W. R. Sooy, F. L. Vernon, and J. Munushian, Hughes Aircraft Co.

A Linear Phase or Amplitude Modulator for Microwave Signals, by J. Gindsberg, Raytheon Mfg. Co.

Special Consideration in the Design of a Tunable Multielement Waveguide Filter, by R. L. Sleven, Airborne Instruments Lab., Inc.

Strip Transmission Line Corporate Feed Structures for Antenna Arrays, by D. Alstadter and E. O. Houseman, Jr., Melpar, Inc.

Low-Loss S-Band and L-Band Circulators for Use with Masers and Reactance Amplifiers, F. Arams, G. Krayer, and S. Okwit, Airborne Instruments Lab., Inc.

Wednesday Afternoon

33. Electronic Computers: Systems and Applications (WA)

Radar System Simulation Techniques, by J. M. Lambert and A. J. Heidrich, G. E. Co.

Application of the NCR 304 Data Processor to the Synthesis of a Digital Computer Building Block, by G. H. Goldstick and M. Kawahara, National Cash Register Co.

Automatic Checkout Equipment Featuring Test Programs for Diagnostic Checking, by R. B. Whiteley and L. J. Lauler, Lockheed Aircraft Co.

The Automatic Position Survey Analyzer and Computer, by F. J. Alterman, General Mills, Inc.

34. Symposium on Sequential Circuit Theory (WA)

A Survey of the Theory of Finite-State Logical Machines, by D. Huffman, MIT.

Mathematical Models for Sequential Machines, by S. Seshu, U. of Toronto.

Information Transfer in Asynchronous Systems, by D. E. Muller, U. of Illinois.

35. Component Parts—II (WA)

A Practical, Comprehensive Component Application Program, by C. G. Walance, Hughes Aircraft Co.

Army Electronic Research: Theory to Reality, by L. J. D. Rouge, U. S. Army Signal R&D Lab.

A Review of the Influence of Recent Material and Technique Development on Transformer Design, by H. Nordenberg, Bu. Ships.

Improvements Made in Electronic Parts During the Past Ten Years, by H. V. Noble, Wright Air Devel. Center.

An Analysis of Printed Wire Edge Connectors, by D. R. Sheriff, Ampex Corp.

36. Space Electronics (WA)

A Time Redundancy Instrumentation System for an ICBM Re-Entry Vehicle, by R. E. Schmidt, J. R. White and R. A. Porter, AVCO.

A General Purpose FM Transmitter for Airborne Telemetry, by P. E. Tucker and R. T. Murphy, Lockheed Aircraft Corp.

The Tricot System, by D. F. Gumb, Aero Geo Astro Corp.

A Circularly Polarized Feed for an Automatic Tracking Telemetry Antenna, by R. C. Baker, Radiation, Inc.

37. Communication by Radio and by Wire Line (C)

Design Considerations for Space Communications, by J. E. Bartow, G. N. Krassner, and R. C. Riehs, U. S. Army Signal R&D Lab.

Inverse Ionosphere, by G. D. Hulst, ITT.

A Frequency Stepping System for Overcoming the Disastrous Effects of Multipath-Distortion on High Frequency FSK Communications Circuits, by A. R. Schmidt, Rixon Electronics.

A High-Stability Linear Phase Voice Frequency Multiplex, by D. Karp, R. M. Lerner, J. F. Mercurio, Jr., and W. E. Morrow, Jr., Lincoln Lab, MIT.

A 2500-Baud Time-Sequential Transmission System for Voice Frequency Wire Line Transmission by J. C. Myrick and G. Holland, Rixon Electronics, Inc.

38. Propagation and Antennas—I (C)

Tropospheric Scatter Propagation Characteristics, by A. J. Svien, Collins Radio Co. and J. C. Domingue, Signal Communications Dept., Ft. Huachuca, Ariz.

Optimum Antenna Height for Ionospheric Scatter Propagation, by R. G. Merrill, Nat. Bureau of Standards.

Terrain Return Measurements at X—, K_u—, and K_a—Band, by R. C. Taylor, Ohio State U.

Theory of Radar Return from Terrain, by W. H. Peake, Ohio State U.

A New Concept in High-Frequency Antenna Design, by R. H. DuHamel and D. G. Berry, Collins Radio Co.

Large Antenna Systems for Propagation Studies, by I. Kamen, General Bronze Corp.

39. Microwave Theory and Techniques (C)

Some Comments on the Classification of Waveguide Modes, by A. E. Karbowiak, Standard Telecommunication Labs., Ltd.

Noise Figure of Receiver Systems Using Parametric Amplifiers, by J. Sie and S. Weisbaum, RCA.

Low-Noise Parametric Amplifiers and Converters, by T. B. Warren, ITT Labs.

Microwave Techniques in Measurement of Lifetime in Germanium, by A. P. Ramsa, Monmouth College, H. Jacobs, and F. A. Brand, U. S. Army Signal Res. and Develop. Lab.

Microwave Mixer Performance at Higher Intermediate Frequencies, by M. Cohn and J. B. Newman, The Johns Hopkins U.

Thursday Morning
March 26

40. Theory and Practice in Russian Technology (WA)

Highlights of Soviet Information Theory, by P. E. Green, Jr., Lincoln Lab, MIT.

Digital Computer Activities in the Soviet Union, by N. R. Scott, U. of Michigan.

Theory and Practice in Automatic Control, by W. E. Vannah, McGraw-Hill.

41. Circuit Theory II—Analysis and Synthesis (WA)

Sensitivity of Transmission Zeros in RC Network Synthesis, by F. F. Kuo, Polytech. Inst. Brooklyn.

Synthesis of Active Networks—Driving-Point Functions, by N. DeClaris, Cornell U.

Linear Modular Sequential Circuits and Their Application to Multiple Level Coding, by B. Friedland and T. E. Stern, Columbia U.

Taylor-Cauchy Transforms for Analysis of a Class of Nonlinear Systems, by Y. H. Ku, A. A. Wolf, and J. H. Dietz, U. of Pennsylvania.

42. Ultrasonic Engineering—I (WA)

Cavitation Erosion of Sonic Radiating Surfaces, by H. F. Osterman, Branson Ultrasonic Corp.

Piezoelectric and Dielectric Properties of Ceramics in the Potassium-Sodium Niobate System, by L. Egerton and D. M. Dillon, Bell Telephone Labs., Inc.

Transducer Properties of Lead Titanate Zirconate Ceramics, by D. Berlincourt, B. Jaffe, H. Jaffe, and H. Krueger, Clevite Res. Center.

43. Military Electronics Looks Forward (WA)

Measurement of Missile Miss Distance, by A. E. Hayes, Jr., Ampex Corp.

Radar Testing for a War Environment, by R. W. Hanford, Overland, Mo.

Trends in Inertial Navigation, by F. Stevens, Nortronics.

Space Vehicle Electromagnetic Communications and Tracking, by H. Hoffman, Jr., Rome Air Devel. Center.

44. Frontiers of Industrial Electronics (WA)

Some Characteristics of the Industrial Electronic Business, by H. A. Strickland, Jr., General Electric Co.

Automation Trends in the Bank Industry, by B. Miller, Nat'l Assoc. Bank Auditors and Controllers.

Industrial Electronics—The Growing Servant of Mankind, by T. A. Smith, RCA.

45. Man-Machine System Design (C)

Communications Display and Control—A New Concept, by R. J. Meyer, Collins Radio.

The Effect of Loop Characteristics Upon Human Gain, by J. S. Sweeney, USNRL, and A. Graham, Antioch College.

The Influence of Nonlinear Transfer Function on Cathode-Ray Tube Visual Detection Threshold, by C. W. Miller, Cornell Aeronaut. Lab., and W. R. Minty, General Electric Co.

Human Factors in the Design of the NRL Nuclear Reactor Control System, by H. J. Berliner, M. P. Young, and G. F. Wall, USNRL.

46. Antennas—II (C)

Electrically Small DF Antenna, by E. McCann and H. H. Hibbs, Melpar, Inc.

Experiments and Calculations on Surface-Wave Antennas, by R. G. Malech and S. J. Blank, Airborne Instruments Lab., Inc.

Ferrite Excited Slots with Controllable Amplitude and Phase, by H. E. Shanks and V. Galindo, Hughes Aircraft Co.

Improved Feed Design for Amplitude-Monopulse Radar Antennas, by J. P. Shelton, Aero Geo Astro Corp.

The Directional Coupler Antenna, by C. Fink, Litton Industries of Maryland, Inc.

Abitrarily Polarized Planar Antennas, by F. J. Goebels, Jr. and K. C. Kelly, Hughes Aircraft Co.

47. Instrumentation: Devices and Circuits (C)

Printed Circuit DC Motors for Electronic and Instrument Applications, by R. P. Burr, Circuit Research Co., and J. Henry-Baudot, Societe d'Electronique et d'Automatisme.

A 100 CPS X-Y Recorder, by J. P. Brady, Jr., Sanborn Co.

A Proposed Automatic Test Set for the Measurement of Communication Cable Parameters, by H. N. Aviles, Western Electric.

A Precision 60-Mc Logarithmic Amplifier, by S. Cohen, H. Laskin, E. Schecker, and B. Woodward, Airborne Instruments Lab., Inc.

Design and Development of a Noise and Field Instrument for 1000 to 12,000-Mc Frequency Range, by A. Borck and M. Rodriguez, Empire Devices, Inc.

48. Electronic Computers: Components and Circuits (WA)

Magnetic Drum Time Compression Recorder, by W. R. Chynoweth, General Electric Co., and R. M. Page, USNRL.

Fast Microwave Logic Circuits, by D. J. Blattner and F. Sterzer, RCA.

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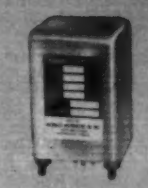

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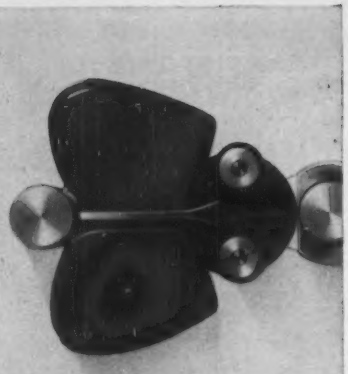

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Asynchronous Electronic Switching Circuits, by M. Kliman and O. Lowenschuss, Sperry Gyroscope Co.

The Cycle Splitter—A Wide-Band Precision Frequency Multiplier, by B. E. Keiser, Missouri Research Labs., Inc.

49. Circuit Theory III—Applications (WA)

Panoramic Spectrum Analyzer in Real Time, by B. D. Steinberg and W. G. Ehrich, General Atronics Corp.

A Long-Memory Delay-Line Analog Recirculator, by M. S. Zimmerman, W. G. Ehrich, and D. E. Sunstein, General Atronics Corp.

Choice of the Shape of the Input to a Spectrum Analyzer in Terms of Its Effect on Transient Selectivity and Signal Detectability, by W. Gersch, Columbia U.

A Minimum Distortion Tapered-Transmission-Line Transformer for Pulse Application, by H. Amemiya, RCA.

Transistor Digital Tape Record Circuit, by A. E. Hayes, Jr., Ampex Corp.

50. Ultrasonic Engineering—II

Thickness-Shear Mode Barium Titanate Ceramic Transducers for Ultrasonic Delay Lines, by J. E. May, Jr., Bell Telephone Labs., Inc.

Vibrations of Ferroelectric Transducer Elements Loaded by Masses and Acoustic Radiation, by F. Rosenthal, Raytheon Mfg. Co., and V. D. Mikuteit, Battelle Memorial Inst.

Effect of Electrical and Mechanical Terminating Resistances on Loss and Bandwidth According to the Conventional Equivalent Circuit of a Piezoelectric Transducer, or How to Get the Most Out of Your Ultrasonic Delay Line, by R. N. Thurston, Bell Telephone Labs.

Measuring the Characteristics of Present-Day Ultrasonic Delay Lines, by J. J. G. McCue and M. Axelbank, Lincoln Lab, MIT.

Ultrasonic Welding Equipment, by J. N. Antonevich, Battelle Memorial Inst.

51. Concepts and Programs (WA)

An Orbit Program for Engineering Use, by H. R. Smith and B. H. Bloom, RCA.

A Study and Design Evaluation of the Throw-Away Maintenance Concept, by J. J. Andrea, Collins Radio Co., and M. V. Ratynski, Rome Air Devel. Center.

Amplitude Modulated Video Integrator, by R. E. Ellis, Aero Geo Astro Corp.

The Significance of Specifications in Government-Sponsored Technical Development Programs, by J. Cryden, Hughes Aircraft Co.

52. Communication Engineering in Broadcasting (C)

Transmission of Television Signals over a Broad-Band Tropospheric Scatter Link, by L. Pollack, ITT Labs.

Installation and Operational Aspects of a Private Television Microwave System, by A. Shelton, WSM.

Mobile Microwave Television Pickup Operational Experiences, by G. E. Hamilton, American Broadcasting Co.

Effect of Frequency Cutoff Characteristics on Spiking and Ringing of TV Signals, by A. D. Fowler and J. D. Igleheart, Bell Telephone Labs., Inc.

50-Kilowatt Antenna Switching System, by J. W. Smith, Collins Radio Co.

53. Antennas—III (C)

Log Periodic Feeds for Lens and Reflectors, by R. H. DuHamel and F. R. Ore, Collins Radio Co.

Broad-Band Conical Helix Antennas, by H. S. Barsky, American Electronic Labs., Inc.

Very Broad-Band Feed for Paraboloidal Reflectors, by J. R. Tomlinson and M. N. Fullilove, Melpar, Inc.

Far Field Patterns of Circular Paraboloidal Reflectors, by G. Doundoulakis and S. Gethin, General Bronze Corp.

Effects of Random Errors on the Performance of Antenna Arrays of Many Elements, by L. A. Rondinelli, Hughes Aircraft Co.

The Hourglass Scanner, a New Rapid Scan, Large Aperture Antenna, by M. N. Fullilove, W. G. Scott, and J. R. Tomlinson, Melpar, Inc.

54. Instrumentation for High-Speed Data Acquisition (C)

A 64-Channel Millimicrosecond Time Analyzer, by T. P. Lang, Sperry Microwave Electronics Co.

Magnetic Recording and Reproduction of Pulses, by D. F. Eldridge, Ampex Corp.

An Improved Method of Calibrating FM Magnetic Tape Transports, by L. Bohnstedt, Ampex Corp.

Ratrase, a High-Capacity, Low-Level Automatic Data Handling System, by G. F. Mooney, Hollywood, Calif.

A Data Processing System Using Glow Tubes, by S. K. Chao, Sylvania Electric Products, Inc.

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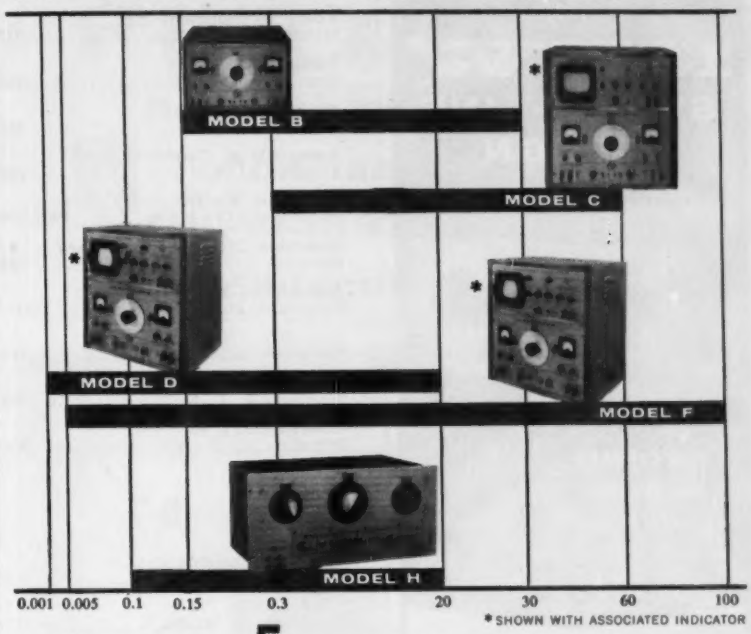

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SERVOSCOPE® makes preproduction problem-solving on servo systems, equipment, and components accurate—and flexible.

Wide range coverage. Fast direct-setting and read-out. High-accuracy measuring of phase, transient response, and gain. Plus—rapid plotting of Nyquist, Bode, or Nichols diagrams.

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- Frequency calibration accuracy of ±2%; phase measurement accuracy of ±1%.
- Accepts any carrier frequency from 50 to 5,000 cps.
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SWEEP GENERATORS
with
NEW
SWEEP-LINE
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- greater than ever performance
- smart appearance
- faster delivery schedules

Telonic Sweeps feature 5% flatness, less than 10 microvolt leakage. Dependable for production, precise for engineering. Variety of markers. Crystal controlled single or harmonic plug-in with external marker provisions on all models. Variable markers available on many models.

Telonic Sweep-Line cabinet features hinged top for easy accessibility, slide-track mounting, perforated top and cooling vents. Dimensions — 20" x 10" x 15". Attractive two-tone finish is satin black and aluminum grey.

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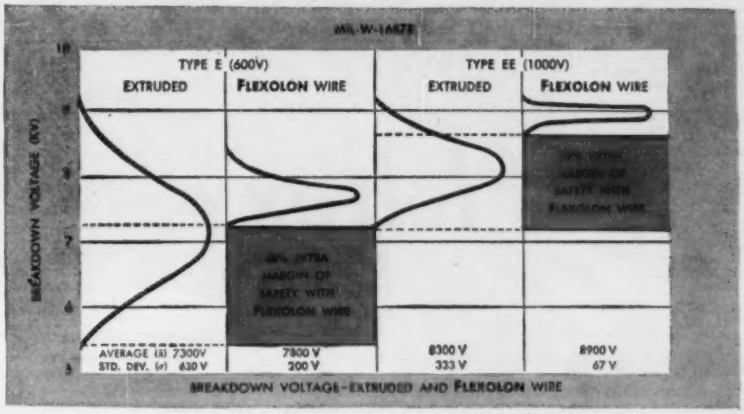

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When you use FLEXOLON wire, insulated with Raybestos-Manhattan "Teflon" tape, you're doing just that. Look at the curves above. Notice the extra safety margin FLEXOLON wire gives you in both types E and EE compared to extruded wire. It exceeds by far the requirements of MIL-W-16878.

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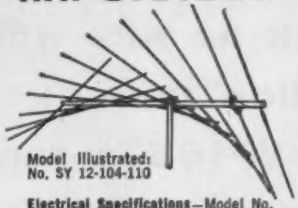

Model Illustrated: No. SY 12-104-110

Electrical Specifications—Model No. SY-12-104-110: Polarization, circular, linear within ½ db. Gain 13 db. F/B-Ratio 30 db. V/S/W/R (50 ohm cable) 1.1/1. Beamwidth at half power points 33 degrees. Max. power input 300 w, with "Balun" supplied.

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- Telrex is equipped to design and supply to our specifications or yours, Broad-band or single frequency, fixed or rotary arrays for communications, FM, TV, scatter-propagation, etc.
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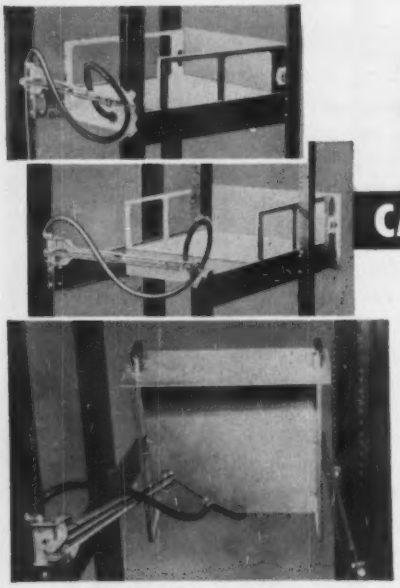

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One support rail is shown cut away to more clearly illustrate complete absence of cable sag at every stage. TOP—installation with slide closed MIDDLE—chassis partly withdrawn BOTTOM—slide extended, chassis tilted

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This new cable retractor's double action maintains a constant tension and correct suspension of cable at all times—permits adequate cable length for full extension and tilting of chassis without hazard of snagging.

May be used with all types of chassis or drawer slides, is adjustable to fit varying chassis lengths, is simple to install, and has proven thoroughly reliable in operation.

Mounts on rear support rails on standard 1¾" hole increments. Cadmium plated cold rolled steel.

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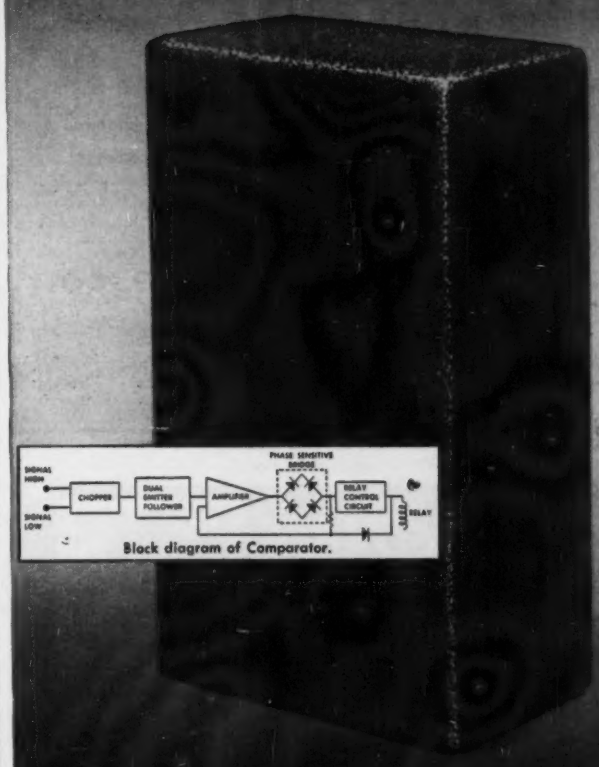
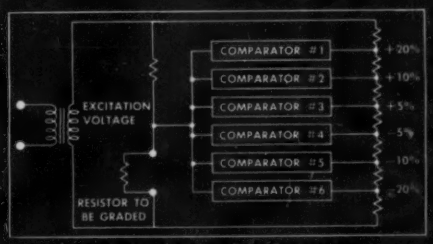


ACTUAL SIZE

Block diagram of Comparator.



A typical application of the Comparator in an automatic resistor grading system.

SPECIFICATIONS

AC Sensitivity: 5 MV
DC Sensitivity: 10 MV
Input Impedance: 2 Megohms (min.)
Output: DPDT relay, contact rating 2 Amps. at 28 V DC
Power Requirements: 115V, 400 cycles, 1 watt
Repeatability of Trip Point: ± 1 MV
Performance will meet or exceed appropriate MIL specifications
AC or AC DC versions available.

Series 200 trips its own DPDT output relay when an unknown input signal exceeds the value of a known input reference level. This direct voltage comparison is the most reliable technique for automatic, programmed accurate measurement with computer speed. Applications, virtually unlimited, include: military ground support devices, airborne instrumentation, production test equipment, alarm/control systems, and many data-gathering and processing systems. Write for reprint of article in "Military Systems Design" magazine. Also for Tech Bulletin. Address Dept. E-38.

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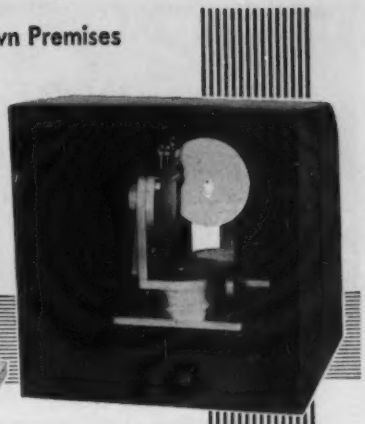

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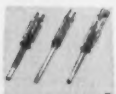

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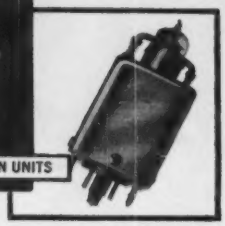

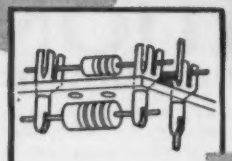

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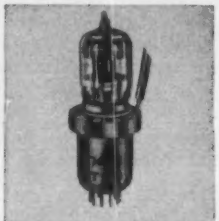

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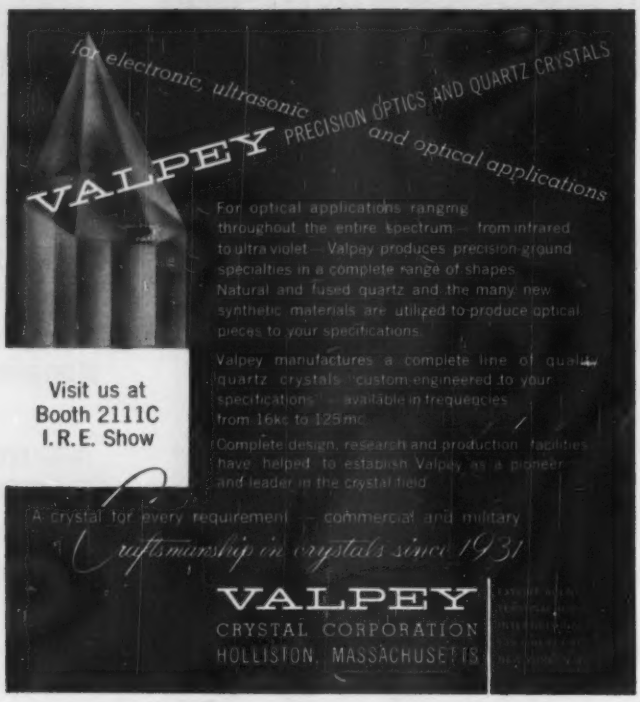
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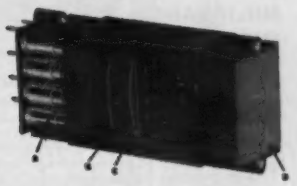

HOW THE EIE IN-LINE DIGITAL DISPLAY OPERATES

The In-Line Display works on a rear-projection principle. When the lamp (A) at rear of the unit is lighted, it projects the corresponding character on the condensing lens (B) through a projection lens (C) onto the viewing screen (D) at the front of the unit.

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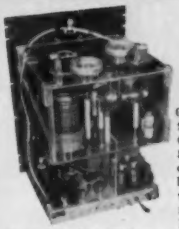

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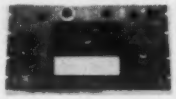

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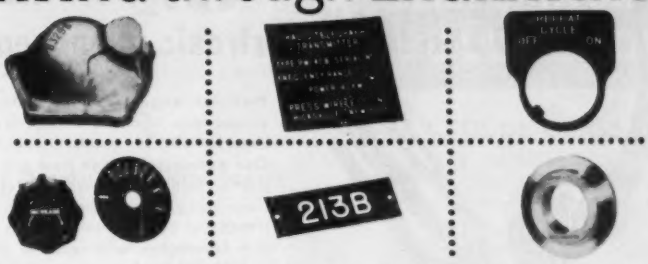

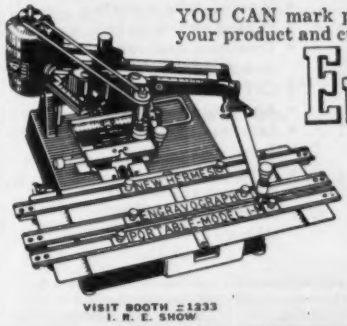

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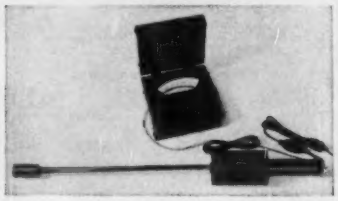

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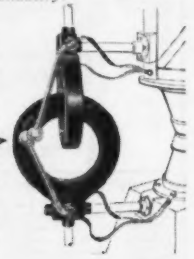

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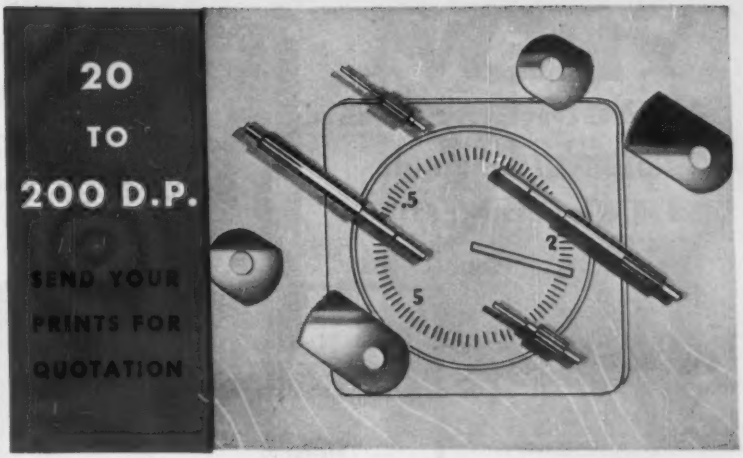

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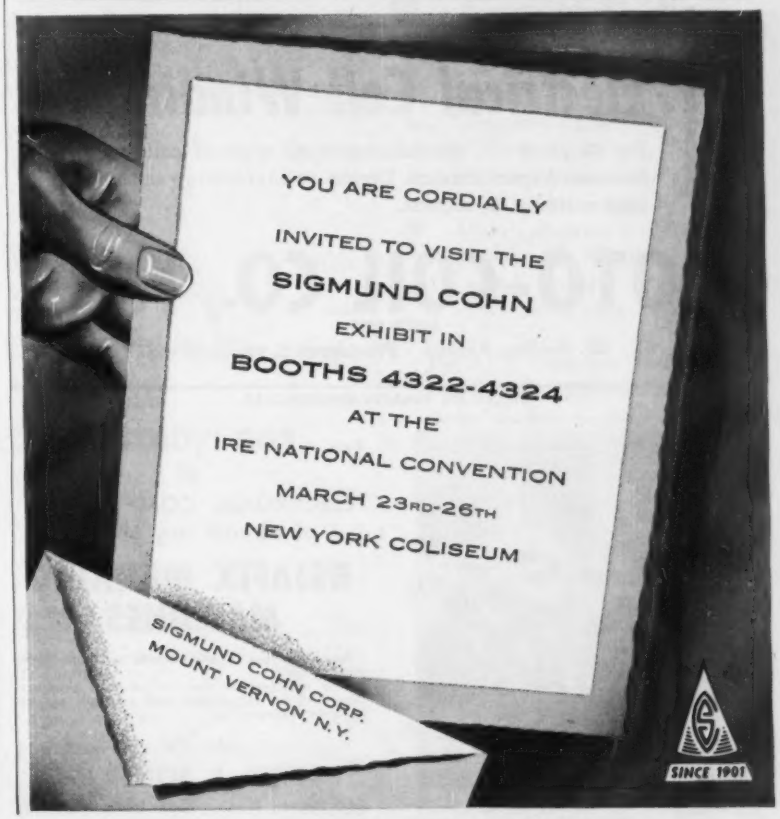

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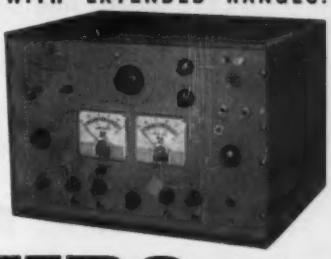

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COMMENT

Microwave Health Hazards

I have read your splendid article ("Researching Microwave Health Hazards," p 49, Feb. 20) with great interest. You are certainly to be commended for having done an excellent job with a tough subject.

I am sure you realize that there are a great many controversial aspects of this problem. On some of these my reaction is to disagree with you, but careful and unbiased thought convinces me that your position is as strong as mine.

I feel this article presents the picture in its true light, and that it should do a lot of good in the hands of your readers. One cannot help but be impressed with the obvious study and work that has gone into its preparation. Your grasp of some of the basic biological difficulties is truly astounding.

COL. GEORGE M. KNAUF
OCCUPATIONAL HEALTH RESEARCH LAB
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Honesty compels us to turn this right back to its source. Without the frank and open cooperation of Col. Knauf and his fellow researchers over eighteen months of accumulating data, we could never have turned out the report. So our thanks to the Colonel are double—for his comment, and for his unstinting help.

Credit Where Due

With regard to the article "Dual-Cavity Microwave Discrimination" (p 74, Jan. 16) by myself and Messrs. Shafer and Baker, there was an error in the credits. Messrs. Shafer and Baker are not with Aeronutronic Systems Inc., as the byline indicates.

Also I have received inquiries on the availability of the cavities. It appears necessary to inform readers that the design work was done while the authors were on the engineering staff at Radio Corporation of America, west coast electronic products department.

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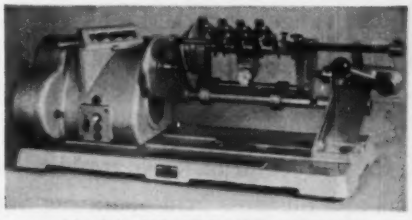

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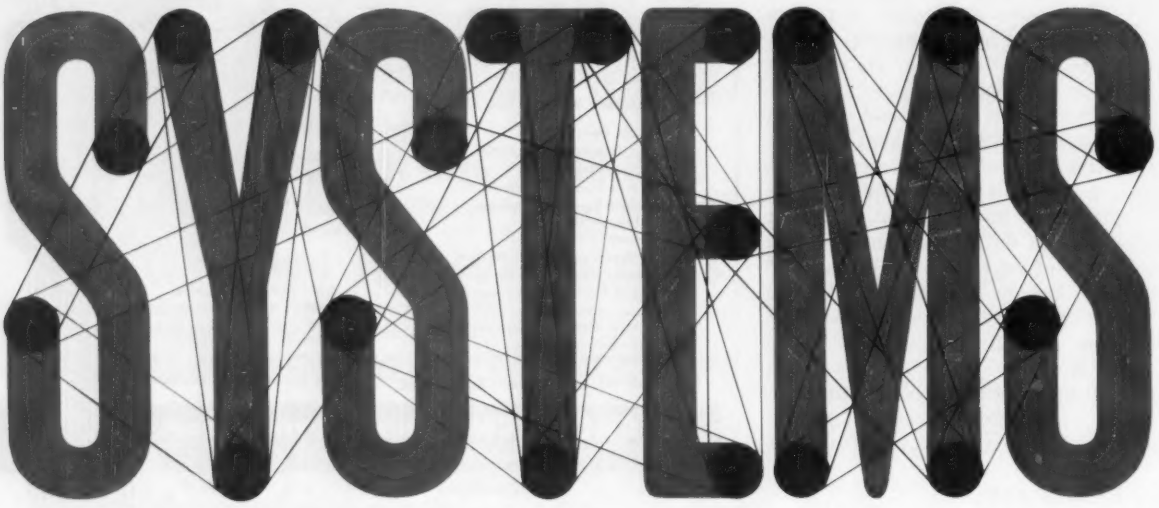

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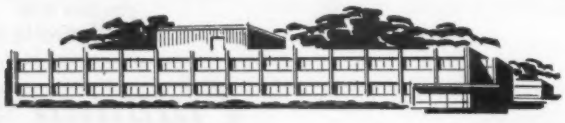

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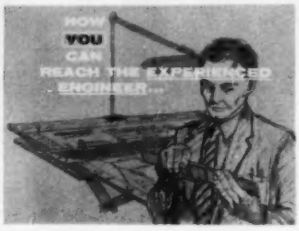

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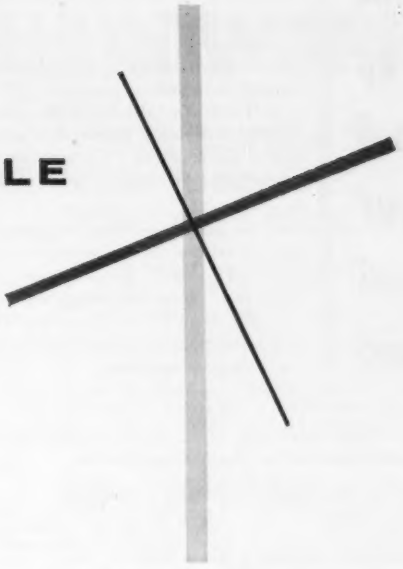

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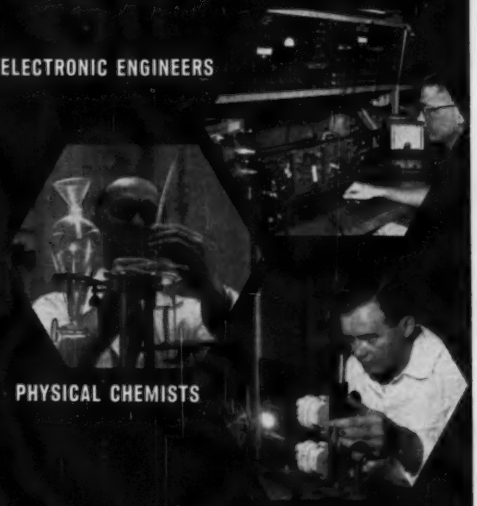

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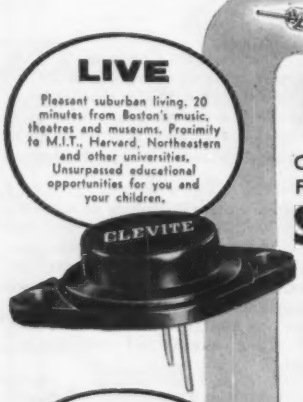

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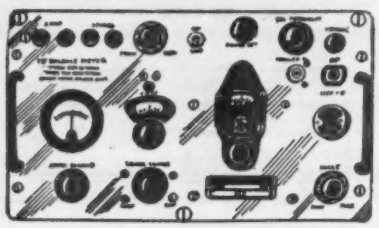

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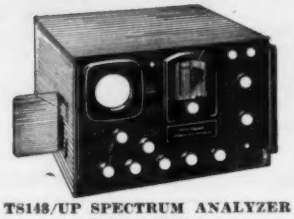

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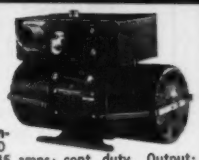

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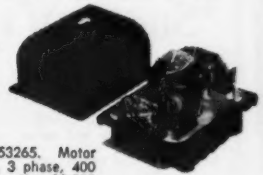
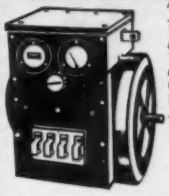


Part #653265. Motor 115 volts, 3 phase, 400 cycle, 8 watts, 20,000 RPM. 3-minute runup, synchro pickoffs, roll 360°, pitch 85°. Synchro excitation 26 volts, 400 cycle, 150 m.a. Vertical accuracy ±½°. Weight 3½ lbs. Approx. dim. 5¾" L., 4½" W., 4½" H. **Price $35.00**

400 CYCLE, 3 PHASE GENERATOR

BY MASTER ELECTRIC

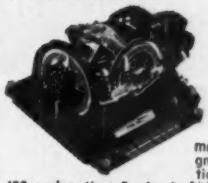


Type AG, frame 364Y, 7.5 kw, 3428 rpm, pf .95. Star connected 120/208 3 phase 22 amps. Delta connected 120 volt single phase 66 amps. Self excited. Complete with control box, voltage regulator, AC voltmeter and frequency meter. Shaft 1" dia., 2" long; overall dim. of unit: 21"x18"x 20". **Price $395.00 each**

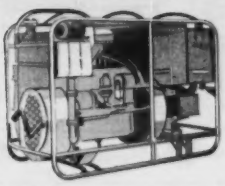
SYNCHROS SERVOS

1CT cont. Trans 90/55V 60 cy.	$34.50
1DG Diff. Gen. 90/90V 60 cy.	34.50
1F Syn. Mtr. 115/90V 60 cy.	34.50
1G Gen. 115V 60 cy.	34.50
1HDG	37.50
1HCT	37.50
1HG	37.50
1SF Syn. Mtr. 115/90V 400 cy.	12.50
23TR6 torque receiver, 115/90 VAC, 60 cycle	37.50
23CT6 control transformer, 90/1V per degree, 60 cycle	37.50
23CX6 control transmitter, 115/90 VAC, 60 cycle	37.50
5CT Cont. Trans. 90/55V 60 cy.	34.50
5D Diff. Mtr. 90/90V 60 cy.	34.50
5DG Diff. Gen. 90/90V 60 cy.	34.50
5F Syn. Mtr. 115/90VAC 60 cy.	34.50
5G Syn. Gen. 115/90VAC 60 cy.	34.50
5HCT Cont. Trans. 90/55V 60 cy.	37.50
5SDG Diff. Gen. 90/90V 400 cy.	12.50
6DG Diff. Gen. 90/90V 60 cy.	25.00
6G Syn. Gen. 115/90VAC 60 cy.	34.50
7G Syn. Gen. 115/90VAC 60 cy.	42.50
7DG differential generator, 90/90 volts, 60 cycle	37.50
C56701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type 1-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type 11-2 Rep. 115V 60 cy.	20.00
C76166 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
C78249 Syn. Diff. 115V 60 cy.	5.00
C78410 Repeater 115V 60 cy.	20.00
C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 22V 60 cy.	7.50
403 Kollsman Autosyn Mtr. 32V 60 cy.	7.50
FPE-25-11 Diehl Servo 75/115 v 60 cy.	12.50
FPE 49-7 Diehl servo motor, 115 volts, 60 cycle, 10 watts	30.00
FPE-43-1 Resolver 400 cy.	19.50
FJE-43-9 Resolver 115V 400 cy.	15.00
R110-2A Kearfott Cont. Mfr.	17.50
R200-1-A Kearfott Cont. Trans.	15.00
R220-1 Kearfott Receiver	20.00
R235-1A Kearfott Resolver	20.00

HONEYWELL VERTICAL GYRO MODEL JG7003A-1



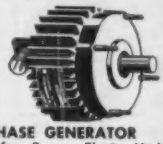
115 volts, 400 cycles, single phase, 35 watts. Pitch and roll Potentiometer pickoffs 890 ohms, 40 volts max. AC or DC. Speed 20,000 rpm, ang. momentum 12,500,000 gm-cm ²/sec. Erection system 27 VAC, 400 cycles, time 5 min. to ½°. Weight 5.5 lbs. **Price $35.00 each**



POWER UNIT PU-104/U

5 KW 120/208 volt AC single or 3-phase permanent magnet type 400 cycle alternator. Alternator is driven by Hercules model ZXB 4-cylinder 4-cycle "L" head liquid cooled gasoline engine. This unit is complete with a control panel. **Price $495.00**

400 CYCLE PM GENERATOR



115/200 volts A.C. 1- or 3-phase, 200 watts. 4,000 r.p.m. Approx. dimensions: 4¾" dia.; 3" long; ½" shaft, AN connector. **$75.00**

400 CYCLE ⅓ PHASE GENERATOR

115 VAC. 3 KVA. Mfg. Bogue Elect. Mod. 2800S. External excitation 107 VDC. 1.1 amp. 3450 rpm. 1" shaft. **$200.00**

MINNEAPOLIS-HONEYWELL RATE GYRO (Control Flight)

Part no. JG7005A, 115 volts A.C., 400 cycle, single phase potentiometer take off resistance 530 ohms. Speed 21,000 r.p.m. Angular momentum 2½ million, CM²/sec. Weight 2 lbs. Dimensions 4-7/32 x 3-29/32 x 3-31/64. **Price $22.50**

VARIABLE SPEED BALL DISC INTEGRATORS

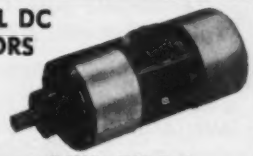
No. 145

Forward & Reverse 2¼-0-2¼. Input shaft spline gear 12 teeth 9/32" dia. ⅜" long. Output shaft 15/64" dia. x 15/32" long. Control shaft 11/32" x ⅜" long. Cast aluminum construction. Approx. size 3" x 3" x 2¾"..... **$17.50**

No. 146

Forward & Reverse 4-0-4. Input shaft 5/16" dia. x ¾" long. Output shaft 15/64" dia. x 9/16" long. Control shaft 11/64" dia. x 11/16" long. Cast aluminum construction. Approx. size 4½" x 4½" x 4". **$18.50 ea.** **(All Shafts Ball Bearing Supported)**

SMALL DC MOTORS



(approx. size overall 3¾" x 1¼" dia.)

5067043 Delco 12 VDC PM 1" x 1" x 2", 10,000 rpm.	$7.50
5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled	15.00 ea.
5069600 Delco PM 27.5 VDC 250 rpm	12.50
5069230 Delco PM 27.5 VDC 145 rpm	15.00
5068750 Delco 27.5 VDC 160 rpm w. brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	8.00
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled	15.00 ea.
5072735 Delco 27 VDC 200 rpm governor controlled.	15.00
5BA10A118 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
5BA10AJ50, G.E., 12 VDC, 140 rpm	15.00
5BA10FJ401B, G.E. 28 VDC, 215 rpm, 10 oz. in., .7 amp, contains brake	15.00
5BA10FJ421, G.E. 26 VDC, 4 rpm, reversible, 6 oz. in., .65 amp	15.00
S. S. FD6-21 Diehl 24 VDC PM 10,000 rpm. 1" x 1" x 2".	4.00

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3 wires—Black.....$1.26
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BLOWERS 115 Volts A.C. 60 cy.

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Westinghouse Motors

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(removed from business machines) $3.75
$3.00 each in lots of 10.

3" Round Elapsed Time Meter

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Square Case $14.50

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A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed.
Limited Supply.... SPECIAL PRICE.... $4.50
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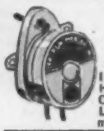
HAYDON TIMING MOTORS



1 Rev 4 hours 115v.....$1.70
1 RPM 115v 60 cy..... 2.60
1 RPM 230v 60 cy..... 1.25
2 RPM 230v 60 cy..... 1.00
3 RPM 115v 60 cy..... 2.60
30 RPM 115v 60 cy..... 2.60
150 RPM 115v 60 cy..... 1.30
HANSEN 4 RPM 115v 60cy. 4.24
CRAMER 4 RPM 115v 60 cy. 4.65
Laboratory special 1 of each motor $16.50

HAYDON DC Motor, part of a $60.00 timing unit....$9.50
The motor alone would cost 32.00

Leach 6104 Relay—115v AC.....9.50
Leach 5107 Relay—115v DC.....7.50

Protect your Test Equipment 50W Isolation Transformer.....$2.35

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4 RPM ...3.90 | 1 RP2H.. 2.80
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GRC-26	APN-9	PRC-14	ARC-27
GRC-27	APN-12	VRC-2-15	ARC-34
GRC-32	APN-22	SCR-399	ARC-49

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AN/GSQ-1 NAVY TYPE PF SPEECH SCRAMBLER

This is a unit designed to be attached to either a radio or telephone circuit to scramble speech or code. This equipment utilizes coded cards in each terminal equipment. Unless the properly numbered card is inserted on the receiving end the speech can not be unscrambled. Complete equipment available. 24 VDC input. Spare parts avail.

SCR-399 GRC-26

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AN/TPS-1B

200 MILE AIR SEARCH RADAR

The TPS-1B is a very late type L-band mobile or portable air search radar. This set will detect aircraft up to 200 miles and up to 40,000 ft. The set is composed of small portable carrying cases that are bolted together to make up the set. A 7" P.P.I. and a 5" "A" scope are provided. This set is in use by the Air Force and Marine Corps. Complete sets available. P.O.R.

AN/TPS-3-AN/TPQ-3

Airsearch or artillery shell tracking radar. The AN/TPS-3 is a 600mc airsearch portable radar. The set has a range of 120 miles on aircraft up to 40,000 ft. This set has a 7" P.P.I. and a 5" "A" scope. The AN/TPQ-3 is a modification of the AN/TPS-3 to provide mortar and artillery shell tracking and plotting. P.O.R.

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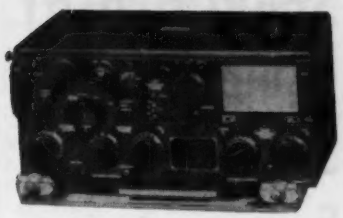

AN/ART-13. 100 watt transmitter designed to provide radio communication by voice, (MCW) or CW telegraphy. Class "B" audio modulator system capable of modulating the carrier at least 90% on voice or MCW. Incorporates automatic tuning mechanism which may be used to select any one of 11 frequencies, range 2000 KC to 18,100 KC. Frequencies 200 KC to 1500 KC range is provided by addition of oscillator 0-16/ART-13A. Excellent—$59.50. 0-16 Low frequency oscillator coil for ART-13, Excellent—$9.95. 24 Volt dynamotor for ART-13 $14.95.

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With 3 tuning units 38 to 1000 mc, Excellent. $159.50.

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LM-20 Frequency meter heterodyne, crystal calibrated. Modulated covering frequencies from 125KC to 20,000KC continuously. This equipment provides accuracies of .02% in the 125 to 2000KC band and .01% in the 2000 to 20,000KC band. With original calib. book and crystal. Brand New $79.50

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Measurements Corp Pulse Generator Model 79B-60 to 100,000 pulses per second, which can be locked with a sine wave or other external source when frequency accuracy is needed. Pulse width 0.5 microseconds & delay time not more than 25% pulse width (at 70% peak). Output voltage is approx. 150 volts to 200 volts peak positive with respect to ground. Cathode follower output with 1000 ohm impedance. Sync. output is 35 volt displaced by ½ period from pulse output. Sync. input may be as little as 2 volts. 110 volts, 60 cycle, 115 watts. Excellent.....$69.50

MD4 - RT - 15
3 cm radar modulator, rec. and trans. complete with all tubes, Magnetron 725 A, 2 ea. 723/AB, 829B, 715B, etc. Excellent $39.50

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10 CM. WEATHER RADAR SYSTEM

US Navy Raytheon 275 KW peak output S band. Rotating yoke Plan position Indicator. Magnetron supplied for any S band frequency specified, incl. Weather Band. 4, 20 and 80 mile range, 360 degree azimuth scan. Sensitive rcvr using 2K28/707B and 1N21B. Supplied brand new complete with instruction books and installation drawings. Can be supplied to operate from 32VDC or 115 volts. Price $975. Ideal for weather work. Has picked up clouds at 50 miles. Weight 488 lbs.

RT39/APG-5 & 15 10CM RADAR. Complete S band RF package. Lighthouse 2C40 xmtr. 2C43 rcvr, TR, 829B pulser, miniature 6AK5 IF strip. Press. 12" dia. 24" lg. New with tubes $275. Ref: MIT Rad. Lab. Series Vol. I, pg. 207.

2.5 KW PRESS WIRELESS XMTR. Type PW-981A 2-23 mc. cw and freq. shift (teletype) MO 25 XTAL channels. Complete $750.

3 CM. KLYSTRON MOUNT

2K25-723A/B mount with cplg. to waveguide run and afc. Shielded incl. tuning rod. Matching tunable output slugs. Dual crystal mount. Pwr cable w/min. plug. Brand new, $28.50.

AN/APN-60

10 CM. RADAR BEACON FOR GUIDED MISSILES. 14" pressurized housing. 2C40 lighthouse OSC. Trans-rcvr unit $275.00.

⅞" RIGID COAX. RG44/U 50 ohm, standard fittings, 10cm stub supported. 12 ft. lengths. Silver plated. New $34.50 each. 12 ft. length. Right angle bends $6 ea.

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COAX MIXER ASSEMBLY S BAND IN21 type crystal detector RF to IF, 'N' fittings, matching Slug, duplex couplings, inf. G.E. New, $18.50.

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SMC-11A Frequency multiplier. Output range 4640-4670 mc. ⅛ to 1 watt on 6th harmonic. Input range 773-778 mc. For direct control of microwave frequencies. New in original sealed cartons. Guaranteed 90 days. Regular price $1500 ea. Our price $495 ea.

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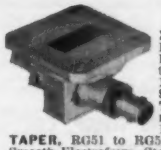

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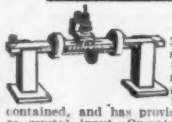

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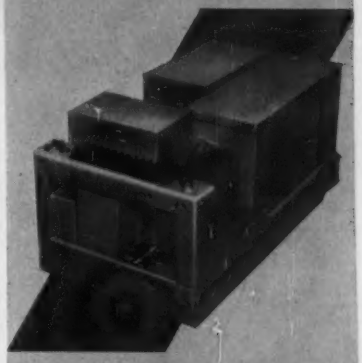

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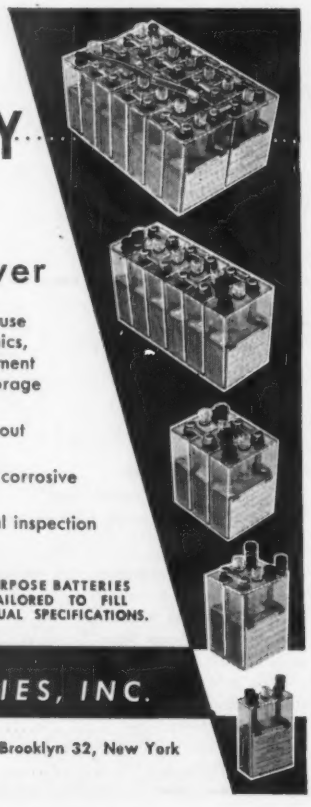

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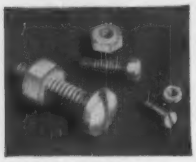

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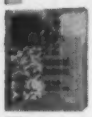

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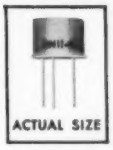

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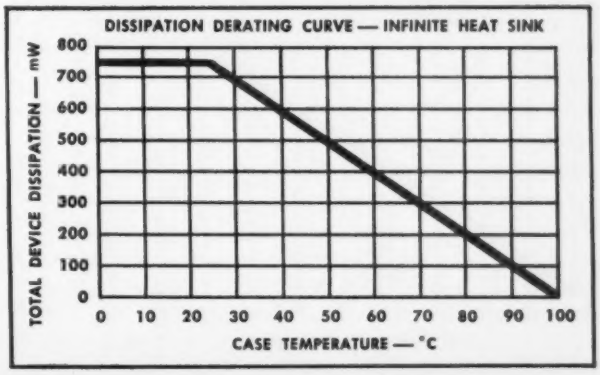

absolute maximum ratings @ 25°C case temperature

	2N1141	2N1142	2N1143	
Collector Voltage Referred to Base	−35	−30	−25	V
Emitter Voltage Referred to Base	−1	−0.7	−0.5	V
Collector Current	−100	−100	−100	mA
Emitter Current	100	100	100	mA
Device Dissipation (infinite heat sink)	750	750	750	mW
Collector Junction Temperature	+100	+100	+100	°C
Storage Temperature Range		−65 to +100		°C
Thermal Resistance Junction to Mounting Base	0.1	0.1	0.1	°C/mW

typical characteristics @ 25°C case temperature

Frequency Cutoff (Common Base)	750	600	480	MC
Collector Reverse Current, $V_{cb} = -15V$, $I_e = 0$	1	1	1	mA
Saturation Voltage, $I_c = -70mA$, $I_b = 17.5mA$	2	2	2	V
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